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ARITHMETICK

IN

EPITOME:

OR, A

122c

COMPENDIUM

OF ALL ITS

RULES.

BOTH

VULGAR *and* DECIMAL.

In Two PARTS.

To which are now Added,

Clear and plain DEMONSTRATIONS
deduced from the Principles of *Arithmetic*
itself; without either Reference to *Euclid*
or Use of *Algebra*.

By W. WEBSTER, Writing-Master.

The SIXTH EDITION, carefully Corrected.

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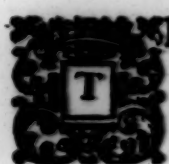
~~THE HISTORY OF THE~~

To the Right Honourable

Sir Robert Walpole,

Knight of the Most Noble Order
of the Garter, First Lord Commissioner
of the Treasury, and Chancellor of
the Exchequer, &c.

S I R,

HO' the Distrust so natural to
a young Author on his first
Performance, did indeed dis-
courage me from complying
with my Inclination, in offering this
Attempt to Your Honour on its first
publication; yet being a little encour-
aged by the favourable Reception its
first Edition met with in the World; I
did, with all Humility, presume to lay
the second Impression at your Feet;
well knowing the Advantage it would
A 2 appear

DEDICATION.

appear with under the Patronage of a NAME so eminent for the Encouragement of *Clerkship*, and of every other Part of useful *Literature*.

Upon the third Revival of this Work for the Press, I made such Additions and Improvements, as have, I hope, given it somewhat a better Title to so great a Protection; but still its Imperfections, I am very sensible, will be but too apparent to Your Honour's Penetration: Yet that Goodness, of which I have already had so abundant Experience, gives me Hopes Your Honour will both excuse what may remain amiss, and forgive this renewed Presumption of,

Your HONOUR's

Most Obedient, and

Most Humble Servant,

William Webster.



THE P R E F A C E.

THE Indulgence with which the former Editions of this Treatise have been received, has encouraged me to endeavour the making it still more worthy the acceptance of the Publick; not only by correcting the many Errors which had before escaped, but also by enlarging it with very considerable Additions: Having from the third Impression added the *Theory* to the *Practic Part*, and endeavoured to inform the Reader's judgment, as well as to assist his memory.

And this I have attempted in a manner very different from the ordinary practice of Writers on this Subject, having never once quoted *Enclis*, nor perplex'd the Learner

The PREFACE.

with (to him unintelligible) *Algebraical*
Demonstrations.

ARITHMETIC and GEOMETRY are justly looked upon as the two main pillars of the Mathematics, upon which the whole Fabric is rais'd; but in comparing them, they are too often confounded: For how great a similitude soever there may be betwixt them, in some respects; yet, as their Subjects are different, so their Principles are certainly distinct, and each may be accounted for without references to the other. Such Comparisons may indeed be useful by way of Illustration, and give great satisfaction to those who have a competent knowledge in both; but conclusions from *Geometrical* Demonstrations are beyond the reach of the young Arithmetician; and the Theory of *Lines* and *Diagrams*, as they are commonly made use of, can only serve to bewilder and confound him.

ALGEBRA, indeed, is not properly a Science distinct from Arithmetic, but is only a different method of Computation, performed by substituting *Letters* in the place of *Figures*, and expressing the several parts of the operation by *Symbolical Characters*. 'Tis true, great discoveries have been made in Numbers by this means, and Arithmetic

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tic owes many of its improvements to this admirable invention: Besides, it furnishes us with a short way of arguing, and brings the proofs of a proposition into a little compass. But however useful it may be to those who understand it, it is certainly an unintelligible jargon to the mere Numerist, and can give him very little satisfaction when laid before him as Demonstration.

Our knowledge in science should rise gradually from one step to another, and our references should be always backwards to what went before; but as the useful parts of Arithmetic have been commonly taught by practical Rules, which are usually taken upon content, so little exactness is generally observed in the order of their delivery, as to their dependence upon each other: The reason of which is plain; for as all Affairs do not require the whole knowledge of Numbers, and as most common Business may be done without much skill in *Fractions*; so it is not only common, but reasonable enough, to carry the Learner thro' whatever may be performed by *Whole Numbers*, before he is entered upon the greater difficulties of *Fractional Parts*. However, the gradation mentioned, should be observed as much as possible; especially in the Business of Demonstration; and the Maxims referred to for explanation,

The PREFACE.

planation, should never be of a more abstruse nature than the thing to be explain'd.

I have therefore endeavoured to give the inquisitive Reader who would understand the reason of things, all the satisfaction I can; and have attempted to account for the Principles of Arithmetic from such self-evident Propositions, and natural considerations, as flow most immediately from Numbers themselves, and fall within the comprehension of such who are the common consulters of *Arithmetical Treatises*; and who, it may be presumed, are generally unacquainted with the more abstruse parts of the Mathematics.

My first design in this Treatise was, according to its Title, to epitomize the Art; and to reduce to a *pocket Size*, what has sometimes been swell'd to a *folio*. Indeed what I first published, was no more than a practical Memorandum, and consequently consisted only of Rules and Examples, with few or no explications: but tho' the enlargements are now very considerable, I have not yet gone beyond my design; it is still a Compendium, and far short in bulk of other Treatises on the subject. I may therefore now recommend it to the ingenious *Clerks* and *Accountants* of the several

The PREFACE.

ral Offices of *Great Britain*, (for whose use especially it was at first design'd) and to such other *Gentlemen* whose Business requires the practice of Arithmetic, with more confidence than before; it being very little increased in Size, tho' very much improved in Precept.

As I suppose my Reader acquainted with the manner of performing the common Rules of *Addition*, *Subtraction*, *Multiplication* and *Division*; so I have made the Work short, by omitting such needless instructions: but the *Reasons* of those operations (being the Fundamentals of Arithmetic) I thought necessary to lay down. The *Rule of Three* I have also endeavoured so to explain, that the application of *Proportion*, as it runs thro' almost all the other Rules, may be fully understood.

And for those practices of Arithmetic which will admit of no other than an *Algebraical* Demonstration, being generally parts more curious than useful, such as are some propositions in *Progression*, and the *Double Rule of False*; I have thought it sufficient to give the practical Rules for their performance, without their Demonstration; since those who are proficient in *Algebra*, cannot be thought to want such explanation;

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tion; and those who are not, cannot be supposed to understand it.

I have indeed ventured to account for the Extraction of the Roots, in a manner which seems something contradictory to my profess'd design: but when it is considered that the Subject of those operations is intirely *Geometrical*, though the Operations themselves are *numerically* performed, it will be found that there is no other rational method of Demonstration, but that of *Lines*; which, however, I hope, I have so laid down, as to be clear and intelligible to every Reader of common sense, who but understands the difference betwixt a *Line*, a *Surface*, and a *Solid*.

As to the disposition of the *Chapters*, they follow much in the same order as they are generally taught in *Schools*: For tho' I am sensible, that the Rules of *Practice* are not thoroughly to be understood without some knowledge of *Vulgar Fractions*, yet I have chose to place Fractions in the last Chapter of *Vulgar Arithmetic*, because (as I before observed) most common Business may be done by whole Numbers. So the speculative Rules of *Progression*, or *Arithmetical* and *Geometrical Proportion*, which, in a just *Theoretic* way of treating the subject
of

The PREFACE.

of Numbers, ought to precede the *Rule of Three*, I have thought better to place just before *Vulgar Fractions*: however, *Progression* and *Vulgar Fractions*, being each distinct Chapters, the Reader may look into them whenever he thinks it most proper.

The second Part of this Treatise, which contains the Doctrine of *Decimal Fractions*, &c. is a kind of Arithmetic peculiarly, as it were, adapted to the concerns of *Gentlemen*: I have therefore been more large than ordinary upon that Subject, and have run over the several Rules again, to shew its particular use and application. In the Chapter of *Interest* and *Rebate*, its excellency will most appear, every Calculation of that kind being performed to great advantage by *Decimal Numbers*. Under that head will likewise be found several useful *Tables* (which, that they might be perfectly correct, are exactly engrav'd on Copper) for the ready discovering the amount, and present worth both of single Sums, and of *Annuities*. And as the *Interest of Money* is now at a lower Rate than when this Treatise was first published, I have in this Impression added *Tables* at 3 and 4 *per Cent.* to those before published at 5 and 6. There are, besides these, some other necessary *Tables* interspersed through this

The PREFACE.

part of Arithmetic (which are also with the same exactness, printed from Copper Plates); as those for the reduction of the known parts of Coin, Time, Weight, and Measure, into decimal Parts of their proper *Integers*; and also that most useful *Table*, which shews the number of Days from any day in any Month to the same day in any other. The *Contents* will shew where to find any of these things; and in the Work itself, are sufficient explanations both of their formation and use. I shall therefore add nothing further by way of Preface, but submit the whole Performance to the judgment and candour of the Publick.



ERRATA.

PAGE 33. Line 24. for 17 gallons, read 19 gallons.
P. 47. l. 11. for 19d. per lb. read 19d. $\frac{1}{2}$. P. 59.
l. 8. add, Tare 17 lb. per C. P. 59. l. 14. for 545 C.
read 548 C. P. 63. l. 9. dele $\frac{1}{2}$. P. 63. l. 14. for 9 $\frac{1}{2}$,
read 9 $\frac{1}{2}$. Clough. P. 71. l. 22. for 81 7s 10d. read
80l. 7s 10d. P. 77. ult. for 98, read 198. P. 148.
l. 4. for add, read and. P. 178. l. 16. for 22, read 22.
P. 160. l. 12. for 2 $\frac{1}{2}$, read 2 $\frac{1}{2}$. P. 160. l. 12. for
2 $\frac{1}{2}$, read $\frac{2}{3}$.

VULGAR

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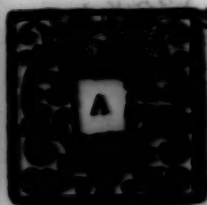


VULGAR ARITHMETIC,

I N

Whole Numbers and Fractions.

P A R T I.



It is inconsistent with the intended brevity of this Treatise, to enter upon a nice inquiry after the first Inventors of Arithmetic, or by what degrees it has been raised to its present perfection; so neither is it my design, in the following pages, to initiate absolute Beginners; but supposing my reader acquainted, at least, with the methods of Adding, Subtracting, Multiplying, and Dividing, (tho' perhaps ignorant of the reasons thereof) I shall lay before him, in as few words as possible, the reasons of those Fundamentals, and their Application throughout all the varieties of practice.

Arithmetic (which is justly defined *The Art of Reasoning*) has for its subject, Number; and teaches us to give proper answers to all such questions as demand *How many?* For the more ready performing of which, the

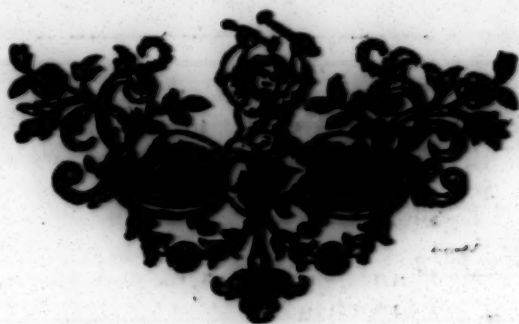
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the ten following Characters, or Figures, have been invented and agreed upon by the greatest part of the known World; viz.

1 2 3 4 5 6 7 8 9 0

and by the various combinations and repetitions of these ten Characters, may every Number, how great soever, be easily and expeditiously express'd.

Thus much in general: I now proceed to particulars.



CHAP.

THE ELEMENTS OF ARITHMETIC

CHAP. I.

*Of the five first and fundamental Rules, viz.
Numeration, Addition, Subtraction, Mul-
tiplication and Division.*

NUMERATION, OF NOTATION.

BY Numeration, we learn the different value of Figures, by their different places; and, of consequence, to read or write any Sum, or Number.

The TABLE.

9	Units.	1
90	Tens.	12
900	Hundreds.	123
9000	Thousands.	1234
90000	X Thousands.	12345
900000	C Thousands.	123456
9000000	Millions.	1234567
90000000	X Millions.	12345678
900000000	C Millions.	123456789

From this Table may be observ'd:

1. The names of the several places, viz. Units, Tens, Hundreds, &c. which proceed (increasing by a ten-fold proportion) from the right hand to the left.

2. That

2. That every Figure hath two values; one in itself, the other from the place it stands in. Thus, on the left side of the table the figure 9 in the upper line, standing in the unit's place, is only nine; but in the second line, being removed into the place of Tens, becomes ninety; and in the third line is nine hundred, &c.

3. That tho' a cypher is nothing in itself, yet it gives value to other figures, by removing them into higher places.

All which being very obvious, I proceed to the next Rule.

A D D I T I O N.

BY Addition we find the whole, or total, of two or more parts, or sums.

In setting down the numbers to be added, care must be taken to place every figure in its proper column; that is, Units under Units, Tens under Tens, &c. Then will the reason of the work (the manner of which, I suppose my reader well acquainted with) appear very evident from this undeniable Maxim, viz. *That the whole is equal to all its Parts.* And the method of setting down the total, may easily be accounted for from the Nature of Numeration, which explains the different value of places, as they proceed from the right to the left hand: For as 9 is the greatest simple character, or figure; so every number exceeding 9, being compound, must require more places than one to express it. Thus the number 10 can no otherwise be express'd in figures, but by removing the figure 1 into the place of Tens, which is done by supplying the Unit's place with a cypher: And as it is the same with every other column (Ten being still the proportion of increase)

con-

consequently, when the sum of any column amounts to 10, or more, the units exceeding, if there be any, or a cypher, if none, must be set under such column; and the ten, or tens, of the amount, carry'd on as so many units, to the next column on the left.

What is here observ'd, as to carrying the Tens (the proportion of increase) from one column to another in Integers, may be as justly apply'd to the numbers we stop at, in adding sums of different Denominations.

For your greater ease in casting up of Money, learn the following Table.

PENCE-TABLE.

Pence.	s.	d.	Pence.	s.	d.
20	is	1 8	80	is	6 8
30		2 6	90		7 6
40		3 4	100		8 4
50		4 2	110		9 2
60		5 0	120		10 0
70		5 10			

Examples in Whole Numbers, and Money.

l.	s.	d.	l.	s.	d.
756	1325		735	18	09 $\frac{1}{4}$
132	4532		423	10	10 $\frac{1}{4}$
458	7345		784	12	05 $\frac{1}{4}$
736	1298		297	08	04
857	8473		542	11	11 $\frac{1}{4}$
241	5249		298	14	07 $\frac{1}{4}$
3180	28222		3082	17	00 $\frac{1}{4}$ Total.

Examples.

Examples in Avoirdupois and Troy Weights.

AVOIRDUPOISE.

<i>Tons.</i>	<i>C.</i>	<i>q.</i>	<i>lb.</i>	<i>oz.</i>	<i>drams.</i>
753	19	3	27	15	15
347	08	1	17	10	06
283	11	0	12	03	10
549	05	2	13	09	07
251	13	0	15	03	11
2185	18	1	02	11	01 <i>Total.</i>

TROY-WEIGHT.

lb.	oz.	dwt.	grs.	
327	11	19	23	
429	10	17	19	
274	08	13	09	
478	10	12	05	
326	09	18	11	
1838	04	01	19	Total.
1510	04	01	20	{ The without the Top-line.
1838	04	01	19	Proof.

To know how many Drams make an Ounce, or Grains a Penny-weight, &c. see the following Tables, Page 19.

Proof of Addition.

The proof of this Rule is usually by a second addition, without the top-line; which second sum, if, when added to the uppermost line, it makes the first total, the work is supposed right. *See the last Example.*

But

"But it is as good, if not a better Proof, to produce the same total, by adding your columns both up and down.

SUBTRACTION.

Subtraction teaches us, by taking a lesser number from a greater, to find the Remainder.

The reason of this Rule is evident from the same principles as Addition; Subtraction being but the reverse thereof: And the number borrowed in any column (like what we stop at in Addition) being always so many as would make 1 in the next.

Examples in Integers and Money.

<i>Yards.</i>		<i>l.</i>	<i>s.</i>	<i>d.</i>
7146325	<i>Lent</i>	812	13	08 $\frac{1}{2}$
1483972	<i>Paid</i>	190	19	10 $\frac{1}{2}$
<u>Rem. 5662353</u>	<i>Rem.</i>	<u>621</u>	<u>13</u>	<u>09 $\frac{1}{2}$</u>
<i>Proof.</i> 7146325	<i>Proof.</i>	<u>812</u>	<u>13</u>	<u>08 $\frac{1}{2}$</u>

	<i>l.</i>	<i>s.</i>	<i>d.</i>
<i>Borrow'd</i>	429	11	02 $\frac{1}{2}$
<i>at several</i>	212	17	10
<i>Times.</i>	356	17	05 $\frac{1}{2}$
<i>Borrowed in all</i>	<u>999</u>	<u>07</u>	<u>00 $\frac{1}{2}$</u>
<i>Paid</i>	<u>519</u>	<u>18</u>	<u>09 $\frac{1}{2}$</u>
<i>Rem.</i>	<u>479</u>	<u>08</u>	<u>02 $\frac{1}{2}$</u>
<i>Proof.</i>	<u>999</u>	<u>07</u>	<u>00 $\frac{1}{2}$</u>

A V O I R.

A VOIR DU POISE.

<i>Tons.</i>	<i>C.</i>	<i>q.</i>	<i>lb.</i>	<i>oz.</i>	<i>Drams.</i>
92	10	0	07	03	13
14	13	3	11	12	05
77	16	0	23	07	08 Rem.
92	10	0	07	03	13 Proof.

T R O Y - W E I G H T .

	<i>l.</i>	<i>oz.</i>	<i>dwt.</i>	<i>grs.</i>
<i>From</i>	672	10	05	09
<i>Take</i>	139	11	05	21
	532	10	19	12 Rem.
	672	10	05	09 Proof.

Proof of Subtraction.

Sums in this Rule are easily proved, by adding their remainders to their lesser numbers; which (if right) will make the greater.

M U L T I P L I C A T I O N .

Multiplication (which is the fourth Rule) serves instead of many Additions; the product of a Multiplication being only the repetition of the Multiplicand so many times as there are units in the Multiplier.

Note, The ready performance of this and the next Rule, intirely depends upon the perfect knowledge of the following Table.

The

The TABLE.

3 times	{	3	12		7 times	{	7	49
		4	16				8	56
		5	15				9	63
		6	18					
		7	21		8 times	{	8	64
		8	24				9	72
		9	27					
					9 times	{	9	81
4 times	{	4	16					
		5	20				2	24
		6	24				3	36
		7	28				4	48
		8	32				5	60
		9	36		12 times	{	6	72
							7	84
5 times	{	5	25				8	96
		6	30				9	108
		7	35				10	120
		8	40				11	132
		9	45				12	144
6 times	{	6	36					
		7	42					
		8	48					
		9	54					

Three terms are used in Multiplication, viz. *Multiplicand*, *Multipplier*, and *Product*.

The following Example shows to which line each term belongs.

EXAMPLE

EXAMPLE.

7563254138 *Multiplicand.*

23456789 *Multiplier.*

68069287242
60506033104
52942778966
45379524828
37816270690
30253016552
22689762414
15126508276

$\begin{array}{r} 1 \\ 8 \div 8 \text{ Proof.} \\ 1 \end{array}$

177409656468442882 *Product.*

That Multiplication serves instead of many Additions, and, consequently, that the truth of its operation depends upon the same Reasons, is easily proved: For suppose it were required to know the sum of four sevens; by Addition, the work will stand thus:

$\begin{array}{r} 7 \\ 7 \\ 7 \\ 7 \\ \hline 28 \end{array}$

Too tedious a method for practice; being discoverable at once, by the Table of Multiplication, to be 28.

Nothing therefore remains to be accounted for in this Rule, but the reason of placing every following particular product a place nearer to the left hand than the product foregoing: But Regard being still had to the nature of Numeration, it will plainly appear, that as we begin with the right hand figure of the Multiplier, or Units place; so the second figure standing in the place of Tens, the product thence arising, must, of

con-

consequence, be ten times greater than the same figure, standing in the place of Units, would have produced; and so on, applying the same consideration to the produce of all the other figures in the Multiplier.

Proofs of Multiplication.

Multiplication is usually thus proved. Cast out the nines from the Multiplicand and Multiplier, and place the remainders on the right and left sides of a Cross, thus made— $\times$. These two figures multiply'd together, must have the nines cast out of their product, and the remainder placed at top: Then casting the nines also out of the product of your Multiplication, place its remainder at the bottom; which if it agrees with the figure at the top, the work is supposed right. See the Example.

A more certain Proof.

A Multiplication sum is then right, when the product, divided by the Multiplier, quotes the Multiplicand; or, divided by the Multiplicand, quotes the Multiplier.

ABBREVIATIONS.

(1st.) When either your Multiplicand, or Multiplier, or both, have one or more cyphers to the right hand, only multiply by the significant figures, and set on the right hand of the product so many cyphers as were in both the Multiplicand and Multiplier.

EXAMPLES.

$$\begin{array}{r} 527000 \\ 4000 \\ \hline 2108000000 \end{array}$$

$$\begin{array}{r} 7583 \\ 7000 \\ \hline 53081000 \end{array}$$

(2^d.) Therefore any number may be multiply'd by 10, 100, 1000, &c. only by placing on the right hand of

of it, one, two, three, or more Cyphers: Thus 7295 multiply'd by 10, is 72950; by 100, is 729500, &c.

(3dly.) To multiply any number by 5, add a cypher to it, and halve it. Or by 15, the same; and add both lines together.

EXAMPLES.

$$\begin{array}{r}
 5334 \text{ multiply'd} \\
 \text{by } 5 \text{ --- } 53340 \\
 \hline
 \text{is --- } 26670
 \end{array}
 \qquad
 \begin{array}{r}
 \text{by } 15 \text{ --- } 53340 \\
 \hline
 26670 \\
 \hline
 \text{is --- } 80010
 \end{array}$$

(4thly.) Any number may be multiply'd by 11, 111, or 112, &c. as in the following Examples.

EXAMPLES.

$$\begin{array}{r}
 7136 \text{ multiply'd by } 11. \\
 7136 \\
 \hline
 78496
 \end{array}
 \qquad
 \begin{array}{r}
 \text{by } 111 \text{ thus: } 7136 \\
 7136 \\
 7136 \\
 \hline
 792096
 \end{array}$$

$$\begin{array}{r}
 \text{And by } 112, \text{ thus: } 7136 \\
 7136 \\
 7136 \\
 7136 \\
 \hline
 799232
 \end{array}
 \qquad
 \begin{array}{r}
 \text{Or thus: } 7136 \\
 112 \\
 \hline
 85632 \\
 7136 \\
 \hline
 799232
 \end{array}$$

We now proceed to our fifth Rule.

DIVISION

In this rule there are also four terms, the *Divisor*, *Dividend*, *Quotient*, and *Remainder*.

EXAMPLE.

Divisor. Dividend. Quotient.

3456789)567895436789(164286

2221653

14809196

9830407

29068198

•14139863

***312707 Remains.**

As Multiplication serves instead of many Additions;
Division supplies the place of many Subtractions;
may be thus made evident. Suppose it were re-
quired to divide 28 by 7; that is, to find how often
7 is contained in 28; by Subtraction the work will
be thus:

28

7

21

7

14

7

7

7

10

[14]

By which we find that 7 is 4 times contain'd in the number 28. But it may be discover'd by the rules of Division at one trial.

There are many methods of working this rule. The following example is divided six several ways.

First.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Second.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Third.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Fourth.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Fifth.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Sixth.

$$\begin{array}{r} 7 \overline{) 28} (2 \\ 14 \\ \hline 14 \\ 14 \\ \hline 0 \end{array}$$

Note. The two last, call'd the *Italian* ways, are most generally used.

Mr. *Altingham* has, indeed, set down nine ways; but his three others are so very like the 1st, 2d, and 3d of these, that they can scarce be call'd different.

ABBREVIATIONS.

(1st.) If there are any cyphers on the right-hand of your Divisor, you may cut off so many cyphers, or figures, on the right-hand of your Dividend; but remember to bring them down (if figures) to the remainder.

EXAMPLE

$$\begin{array}{r}
 21 \overline{) 008645} \overline{) 29411} \\
 \underline{84} \\
 24 \\
 \underline{21} \\
 35 \\
 \underline{21} \\
 1429
 \end{array}$$

(2dly.) By the foregoing rule, you may observe, that to divide by 10, 100, 1000, &c. is only to cut so many figures from the right-hand of the Dividend, as there are cyphers in the Divisor.

EXAMPLE

$$1 \overline{) 000} 43682 \overline{) 735}$$

So the *Quotient* is 43682, the *Remainder* 735.

(3dly.) When your Divisor is 12, or consists only of one single figure, or can be reduced to one, by cutting off cyphers from its right-hand, the work may be easily perform'd in our line, thus:

RULE.

When you are to divide any number under the Dividend, set down the first figure, how often the Divisor is contain'd in it, and write the answer, imagine placed before the next figure; and considering how often your Divisor is contain'd in it, set down the number underneath, as before, and so proceeding through all the figures, set down the remainder last, in the place where your Quotient is to stand.

EXAMPLES.

$$\begin{array}{r} 12345678 \div 11 = 1122334 \\ 12345678 \div 17 = 726216 \\ 5635 \div 15 = 375 \end{array}$$

When you are to divide several numbers by one common Divisor (as in the extracting of Tables, &c.) that you may save trouble, and catch how often your Divisor will go, in convenient course, make a Table of your Divisor, by multiplying it severally by all the nine Digits. Thus, suppose for your Divisor:

1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

When you are to divide any number by one of these nine Digits, you may find how often it will go, by looking in the Table, and seeing how often the Divisor will go into the first figure of the Dividend, and so on, until you find the Quotient of the whole.

a Division by the Division of the

(only) *Amos* 1:11-12
 gather these *Amos* 1:11-12
 with *Amos* 1:11-12
Amos 1:11-12
 tent, together with the *Amos* 1:11-12
 gent of which (if sight) with *Amos* 1:11-12

(only) *Amos* 1:11-12
 by a *Amos* 1:11-12, thus; calling *Amos* 1:11-12
 the *Amos* 1:11-12, *Amos* 1:11-12
Amos 1:11-12; then multiplying the *Amos* 1:11-12
Amos 1:11-12, and calling the *Amos* 1:11-12
 left to the *Amos* 1:11-12
 the *Amos* 1:11-12, in the *Amos* 1:11-12
 calling the *Amos* 1:11-12
Amos 1:11-12
Amos 1:11-12
Amos 1:11-12

TABLES of English Coins, Weights and Measures.

First, of COINS.

ACCOMPTS are kept in Pounds, Shillings, Pence, and Farthings, thus divided:

4 Farthings	} make {	1 Penny,	} thus mark'd {	℥
12 Pence		1 Shilling,		s.
20 Shillings		1 Pound,		£

But the usual Coins are,

		℥	s.	d.
Of Gold,	{ A Sovereign,	} Value {	1	0
	{ A Guinea,		1	0
	{ A Guinea,		1	0
	{ A Guinea,		0	10
	{ A Guinea,		0	10
Of Silver,	{ A Crown,	} Value {	0	5
	{ A Crown,		0	5
	{ A Crown,		0	5
	{ A Crown,		0	5
	{ A Crown,		0	5
Of Copper,	{ A Penny,	} thus {	0	0
	{ A Penny,		0	0
	{ A Penny,		0	0
	{ A Penny,		0	0
	{ A Penny,		0	0

Besides the above-mentioned, we have still in use the names of some other pieces, which are now but imaginary, viz.

		℥	s.	d.
A Mark,	} Value {	0	13	4
An Angel,		0	10	0
A Noble,		0	6	8
		0	6	8

WEIGHTS.

WEIGHTS.

TROY.

24 Grains	} make	1 Pennywt.	} thus mark'd	dwts.
20 Pennywts.		1 Ounce,		oz.
12 Ounces		1 Pound,		lb.

By Troy-Weight are weighed Jewels, Gold, Silver, and all Liquors.

APOTHECARIES.

20 Grains	} make	1 Scruple,	} thus mark'd	℥
3 Scruples		1 Dram,		ʒ
8 Drams		1 Ounce,		℥
12 Ounces		1 Pound,		℔

By these Weights, Apothecaries compound their Medicines, but they sell all their Drugs by Avoirdupois.

AVOIRDUPOIS.

16 Drams	} make	1 Ounce,	} thus mark'd	oz.
16 Ounces		1 Pound,		lb.
28 Pounds		1 quarter of a Hundred,		qrs.
4 Quarters		1 Hundred,		c.
20 Hundreds		1 Ton,		ton.

This is, at present, the common weight of England, by which, Butter, Cheese, and all Groceries, &c. are weighed.

Note, One pound Avoirdupois, is equal to 14 oz. 11 dwts. 15 grs. $\frac{1}{2}$ Troy; and one ounce Troy is equal to 1 oz. 1 dram, and something above $\frac{1}{2}$, Avoirdupois.

WOOL-WRIGHT

1. Clean	1. Clean	1. Clean
2. Claws	2. Claws	2. Claws
3. Paws	3. Paws	3. Paws
4. Tail	4. Tail	4. Tail
5. Feet	5. Feet	5. Feet
6. Head	6. Head	6. Head
7. Neck	7. Neck	7. Neck
8. Back	8. Back	8. Back
9. Sides	9. Sides	9. Sides
10. Belly	10. Belly	10. Belly
11. Legs	11. Legs	11. Legs
12. Hoofs	12. Hoofs	12. Hoofs

For more information, please contact the Wool-Wright Company, 123 Main Street, New York, NY 10001.

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[4]

D R Y

8 Pints	} make	1 Gallon,	} thus mark'd	Gall.
2 Gallons		1 Peck,		Peck.
4 Pecks		1 Bushel,		Bush.
4 Bushels		1 Coom,		Coom.
2 Cooms		1 Quarter,		Qr.
5 Quarters		1 Wey,		Wey.
2 Weys		1 Last,		Last.

L O N G

3 Barley-Corns	} make	1 Inch,	} mark'd as writ.	1760
12 Inches		1 Foot,		1760
3 Feet		1 Yard,		1760
5 Yards and 1/2		1 Pole or Perch,		1760
2 Poles		1 Furlong,		1760
3 Furlongs		1 Mile,		1760

R O A D S

40 Square Perches	} make	1 Road.
4 Roads		1 Acre.

Note, That a Geometrical Pace is 4 Feet, and that there are 1056 such paces in an English Mile.

C L O T H

4 Nails	} make	1 Quarter.	} make	1 Ell.
4 Quarters		1 Yard.		1 Ell.

Note, An Ell Measure is 3/4 of a Yard, and an Ell is 5.

12	} make	1 Dozen.
12 Dozen		1 Small Gross.
12 Small		1 Great Gross.

THE ART AND MYSTERY OF ARITHMETIC

C H A P. II.

Of **REDUCTION.**

Reduction is but an application of Multiplication and Division: For,

First, All great names are brought into small, by multiplying with so many of the little ones as make one of the great.

Secondly, All small names are brought into great, by dividing by so many of the little ones as make one of the great.

Thirdly, To change one sort of money, or weight, &c. into another, is only to bring both into one name, and to divide the one by the other.

EXAMPLES of each Sort.

(First Sort.)

l. s. d.

In 419*l* 12 *s* 3 how many Farthings?

'tis multiply'd by 20, because 20*s*. make 1 *l*. Note. The
 12*s*. are taken in.

85912

'tis multiply'd by 12, because 12*d*. make 1*s*. And here
 the 3*d*. are added.

1030947

'tis multiply'd by 4, because 4 Farthings make 1 Penny.

Answer, 4123788 Farthings.

(Second

(Second Sort.)

In 4123788 Farthings, how many Pounds?

4)4123788(

12)1030947(3

2)085912(

4295 L. 12 s. 3 d. facit.

We divide here by 4, 12, and 20, for the same reasons that we multiply'd by them in the first example.

(Third Sort.)

Change 49967 French Crowns, at 4 6 each, into
Guineas.

Six-pence is a }
French Crown. } 9

21
2
—

49967
9

42 { Six-pence is
a Guinea.

42)413703(9870 Guineas.
378

357
996

410
216

03 Six-pence.

More EXAMPLES.

In 89647 Guineas, how many Pounds Sterling?

Answer, 89929 L. 7 s.

[24]

In 59463 Marks, at 13s. 4d. how many Pounds?

Answer, 39642l.

How many Dollars at 4s. 4d. are there in 89573 Pi-
Sters, at 17s. 6d?

Answer, 361737 Dollars, and 6d. remain.

In 82 lb. 9 oz. 10 dwt. 5 grs. how many Grains?

Answer, 476885 Grains.

In 56 Tns, 13 C. 2 qrs. 21 lb. 7 oz. 11 Drms, how
many Drms?

Answer, 32505211 Drms.

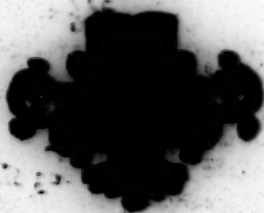
How many minutes since the birth of our Saviour, it
bring 1740 years?

Answer, 914544000 minutes.

How many Gallons are there in 7569 Tuns?

Answer, 1907388 Gallons.

Note, These questions revers'd, will make as many
more good examples.



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CHAP.

AT THE END OF THE VOLUME.

C H A P. III.

*Of PROPORTION, or the RULE of THREE,
Direct, Indirect, and Double.*

THIS Rule is call'd the Rule of THREE, because by three numbers given we find a fourth number sought; which, when the Proportion is direct, must always bear the same ratio, or proportion, to the third number, as the second bears to the first.

The chief difficulty of this Rule lies in stating its questions. For your direction therefore observe, that of the three given numbers, two always contain a suppositum, and the third's Demand.

The number then on which the Demand lies, must always be the third in your stating; of the other two, you will be sure to find one of the same quality with the said third; which being made your first, the number left, must, of consequence, fall in the second place, which second number will also always be of the same kind with the fourth, or number sought.

The question being thus stated, you must (if they are not already so) bring your first and third numbers into one name, and your second (if of several denominations) into its lowest term; then multiplying your second and third numbers together, and dividing the product by your first, the quotient will be the answer of your question, in the same denomination you left your second number. See the Examples.

E X A M P L E S.

(Ex. 1st.) How many Ounces may I buy for 8*l*. if I give after the rate of 2*l*. for 18 Ounces?

If

$$\begin{array}{r}
 \text{l.} \qquad \text{oz.} \qquad \text{l.} \\
 \text{If 2 buy } 12 \text{ --- what will 8? ---} \\
 \underline{8} \\
 2)144(\\
 \underline{} \\
 \text{Answer, } 72 \text{ oz.}
 \end{array}$$

(Ex. 2d.) What must I give for 112 Ells of Holland, if I pay after the rate of 34 l. for 138 Ells?

$$\begin{array}{r}
 \text{Ells.} \qquad \text{l.} \qquad \text{Ells.} \\
 \text{If 138 cost } 34 \text{ --- what will 112?}
 \end{array}$$

$$\begin{array}{r}
 34 \\
 \underline{} \\
 488 \\
 366 \\
 \underline{} \quad \text{l. s. d.} \\
 138)4148(30 \text{ } 1 \text{ } 2 \\
 414 \\
 \underline{} \\
 \dots 8 \\
 20 \\
 \underline{} \\
 138)160(1 \\
 138 \\
 \underline{} \\
 \dots 22 \\
 22 \\
 \underline{} \\
 138)264(2 \\
 276 \\
 \underline{} \\
 226 \\
 4 \\
 \underline{} \\
 138)504(3 \\
 414 \\
 \underline{} \\
 90
 \end{array}$$

The Remainder 8, being Parts of a Pound, are multiply'd by 20, to see what Shillings they will produce; and so the other Remainders by 12, and 4, to bring out the old Pence and Farthings.

This way of valuing the Remainder, is more fully explain'd in the French part of Reduction of vulgar Fractions.

(Ex. 3d.)

[47]

(Ex. 94.) How many yards of Maltin can I buy for 42s. 12s. if 24 yards come to 19s. 6d?

2	2	yards.	1	2
If 19	6	buy	— 24 —	what will 42 12
2			2	20
—			—	
39		5		852
				2
				—
				1704
				5
				—

2)218(
 —
 109 yards

39)8520(218 fact.
 78
 —
 72
 39
 —
 330
 312
 —
 18

P R O O F.

Of every four numbers in direct proportion, the product of the two means multiply'd into each other, will be equal to the product of the two extremes so multiply'd: therefore multiplying your first by your fourth number found, and comparing it with the product of your second by your third, if the products agree, the work is right. Thus, in the first example, 72 (the fourth number found) multiply'd by 2 (the first number) gives 144, equal to the product of 8 times 18, the second and third numbers.

And from hence arises the invention of the foregoing rule, for finding the fourth number; for if the second number, multiply'd by the third, be equal

equal to the first multiply'd by the fourth. It is plain that if the product of the first and second be divided by the first, the Quotient must be the said fourth number; because every Dividend must be equal to the produce of its Divisor and Quotient, the remainder (if any) being also consider'd.

Sums in this rule may also be proved by a back-casting; thus reversing the third Example,

<i>l.</i>	<i>s.</i>	<i>yards.</i>	<i>l.</i>	<i>s.</i>	<i>yards.</i>
If 42	12	will buy 109,	then 19	6	will buy 2½
20		39	2		
852		981		39	
2		327			
1704		1704	251	(2½ yards.	
		3408			
		843			
		2			
		1086			
		18		Remainder of the other	
				being added.	
		1704	1704	(1	
		1008			
		2016			

Though in the former of the foregoing proofs the manner of working the Rule of Three is sufficiently explained for, and therefore of the operation itself is not laid down; yet to shew every body how to look it upon as the plain Rule of Arithmetic, and as the same operation of proportion, was shew'd almost all its other branches; it may, perhaps, help to make it still more evident, to look back again upon the first example, and observe it in another light. The question there asked was, If 2 *l.*—18 *oz.*—8 *l.* Now had it been, If 1 *l.*—18 *oz.*—8 *l.* tis clear, that if 1 *l.* would buy 18 *oz.* then 8 *l.* would buy 8 times as many, that is, 144 *oz.* But then, as think upon

the supposition that 1 £ is the price of 18 oz. so if the price of the 18 oz. is doubled, that is, made 2 £, the plain 144 oz. will then be twice the quantity that 1 £ will buy, and must therefore be divided by 2, to give the true answer. Again, had the supposed price been 3 £, then would 84 have bought but a fourth part of 144 oz. viz. 36 oz. consequently, in what proportion the first number increases, in the same proportion must the fourth number decrease; which is plainly effected by dividing by the first number.

Now, In the operation of the Rule of Three, the first and third numbers, after preparation, are no more regarded, as of any denomination; but are merely used divided with, only as abstract numbers, increasing and decreasing the middle number, as just pointed out.

Now also, The second number, that is, the number of working the Rule of Three, is not to be regarded as the denomination of the first number, but as a number of the same denomination as the first number, and as such, it is to be divided by the first number, to reduce it to a unit.

As the first number is 1 £, and the second number is 18 oz., and the third number is 144 oz., then the fourth number is 84 oz.

	paid.	l.	paid.
	If 32 be sold for 45, what will 1?		
l.		1	
40 Cost.		— l. s. d.	
5 Gain.		32)45(1 8 1 1/2 far.	
		32	
45 Total		—	
		13	
		20	
		—	
		32)260(8	
		256	
		—	
		4	
		12	
		—	
		32)48(1	
		32	
		—	
		16	
		4	
		—	
		96	
		—	
		16	
		—	
		0	

(2d.) Or if damage having happen'd to the Cloth, 5 l. were to have been lost by the whole, then the said 5 l. must have been subtracted from the cost, and the remainder made the second number, as before.

(3d.) If you would barter or exchange your goods for others, first find the value of your own, and then see what quantity of the others the sum will purchase.

EXAMPLES.

EXAMPLES.

What quantity of Pepper, at 3s. 6d. per lb. may I have in exchange for 426 C. of Tobacco, at 53s. per C?

$$\begin{array}{r}
 \text{C.} \quad \text{s.} \quad \text{C.} \\
 \text{First, If } 1 \text{ --- } 53 \text{ --- } 426 \\
 \quad \quad \quad 53 \\
 \quad \quad \quad \hline
 \quad \quad \quad 1378 \\
 \quad \quad \quad 2130
 \end{array}$$

Answer, 2558 shillings.

$$\begin{array}{r}
 \text{s.} \quad \text{d.} \quad \text{lb.} \quad \text{s.} \\
 \text{Then, If } 3 \text{ --- } 6 \text{ --- } 2558 \\
 \quad \quad \quad 2 \\
 \quad \quad \quad \hline
 \quad \quad \quad 3
 \end{array}$$

Answer, 645 Pounds 4

ABBREVIATION.

The work of these things may be much shortened, by dividing their first and second, or first and third numbers, by any figure, & the resulting may remain.

EXAMPLE.

[132]

EXAMPLE

Q If 191 pounds 7 pence, how many would 1766 pence?
 A 191 pounds 7 pence is 191 pounds 7 pence.
 1766 pence is 1766 pence.
 191 pounds 7 pence is 191 pounds 7 pence.
 1766 pence is 1766 pence.
 191 pounds 7 pence is 191 pounds 7 pence.
 1766 pence is 1766 pence.

The number of the pound is 191, and the number of the pence is 7.
 The number of the pound is 191, and the number of the pence is 7.
 The number of the pound is 191, and the number of the pence is 7.
 The number of the pound is 191, and the number of the pence is 7.

Example 2. A Gentleman's daily expences are 13s. 7d. shillings
 which, he yearly lays up 600 Mares, at 6s. 3d. each.

A Gentleman's daily expences are 13s. 7d. shillings
 which, he yearly lays up 600 Mares, at 6s. 3d. each.

each, what is his Estate worth for James?

Answer, 497 £ 37 s 11 d.

A man owing 736 £ 10 s. compounds with his Creditors for 7 s. 9 d. per l. what will that amount to?

Answer, 287 £ 7 s. 10 d 4.

If at 5 s. per ell I gain 8 £ per Cent. by my Cloth, what shall I gain per Cent. if I sell it at 6 s. 3 d?

Answer, 10 £.

If Tobacco, which cost 13 d. per lb. be sold for 18 d. per lb. what is gained per Cent.?

Answer, 38 £ 9 s. 2 d 4.

Bought 5 pieces of Holland, each containing 50 Ells Flemish, at 3 s. 2 d. per ell, what shall I gain in the whole, if I sell it for 5 s. 8 d. per ell English?

Answer, 31 £ 5 s. 4 d.

I have by me 96 lb. of Cloves, which cost me 58 £ but some damage having happened to them, I am willing to lose 6 £, rather than to sell them at less than 52 £, though I cannot? how much more shall I have at hand of

Answer, 7 d 4.

A Merchant sends over to France 45 tons of Lead, at 4 £ 10 s. per Ton, & a 197 £. what quantity of Wine, at 30 d. per pipe, may be brought to France?

Answer, 24 pipes, 17 gallons.

A Merchant sends to Spain 100 pieces of Broad Cloth, each containing 20 Ells, at 4 s. 6 d. per yard, to be sold for 5 s. 6 d. per yard, he also sends 1000 lb. of Wine, at 4 s. per cask, which is worth 10 s. per cask, what is the gain?

Answer, 1000 £.

Two men part, at the first place, one goes South, the other travels north 32 miles, the first, 32 miles a day, the second, how long will it be before they are 200 miles apart?

Answer, 12 days, 9 Hours, 50 minutes.

The Indirect Rule of THREE.

IN the *Indirect Rule of Three*, the numbers are in reciprocal proportion, that is, the fourth number to be found, is to bear the same ratio to the second as the third does to the first, but in an inverted order; that is, the greater the third term is in respect to the first, the less must the fourth be in respect to the second.

This rule differs in its operation, from the *Direct*, in that, after the question is stated, and the numbers of the statings prepared (as in the *Direct Rule*) your first and second must be multiply'd together, and your third number be your Divisor. The Quotient, as before, will be the answer.

EXAMPLES.

(Ex. 1st.) What number of men must be employ'd, to finish, in 12 days, what 43 men would be 35 days about?

<i>days</i>	<i>men</i>	<i>days</i>
If 35	43	12
—		
43		
—		
105		
140		
—		
12)1505(5		
—		

Answer, 125 Men.

(Ex. 2^d.)

(Ex. 2d.) How many yards of Stuff 3 qrs. wide, will hang a Room which requires 420 yards of 5 qrs. wide?

$\begin{array}{ccc} \text{qrs.} & \text{yards.} & \text{qrs.} \\ \text{If } 5 & \text{---} 420 & 3 \end{array}$

$\begin{array}{r} 3 \overline{) 2100} \end{array}$

Answer, 700

The reason of this operation will appear plain (after what has been said in the Direct Rule) by considering the last example. Now it is clear, that if the Stuff, being 5 quarters wide, there are 420 yards requir'd, that were the Stuff but 1 quarter wide, 5 times 420 yards, viz. 2100 yards must be allowed; consequently, if the Stuff be 3 quarters wide, one third part of those yards will be sufficient; therefore 2100 divided by 3, will give the true answer requir'd, viz. 700 yards.

To know whether a Question belongs to the Direct or Indirect Rule of Three.

Observe, If the third number being more than the first number, requires more, or being less, requires less, 'tis Direct; but if the third number, being more, requires less; or being less, requires more, 'tis Indirect.

Or, without any regard to the distinction of Direct and Indirect; if more is required, let the lesser of the two extremes be the Divisor; if less, the greater.

More Questions in the Indirect Rule of Three.

If I lend £. 1367. for 3 months, how long must I keep 42 l. of his, to require myself?

Answer, 9 months, 2 weeks, 6 days.

If 46 Clerks in 32 days finish a piece of writing, in what time would 55 Clerks accomplish the same?

Answer, 26 days, 18 hours, 19 minutes.

A Garrison, consisting of 1539 men, being besieged, have provisions only for 12 days; but it being necessary they should hold out 3 weeks, how many men must be sent out?

Answer, 660 men.

The DOUBLE RULE of THREE.

Questions in this Rule have five numbers proposed, and are generally answered by two findings; of which, one sometimes happens to be Indirect, as in the second Example.

EXAMPLES.

EXAMPLES.

(Ex. 1st.) The carriage of 32 hundred weight 56 miles, comes to 12 s. After the same rate, what must I pay to have 78 hundred weight carry'd 94 miles?

First, If $\begin{array}{ccc} C. & s. & C. \\ 32 & \text{---} & 12 & \text{---} & 78 \end{array}$

$\begin{array}{r} 12 \\ \text{---} \\ 32 \cdot 936(19 \text{ } 3 \text{ facit.} \\ 64 \end{array}$

$\begin{array}{r} 296 \\ 288 \end{array}$

Then, $\begin{array}{ccc} \text{Miles.} & s. & d. \\ 56 & \text{---} & 29 & 3 & \text{---} & 94 \end{array}$

$\begin{array}{r} 12 \\ \text{---} \end{array}$

351

94

1404

3159

56)31994(589

280

499

448

514

504

10

8

12

32)96(3

96

0

12)589(1

21049(

Answer, 2 l. 9 s. 1 d.

Note, It had been the same thing, if the miles had been made the first and second numbers of the first stating; and the C. weights the first and second numbers of the last.

Note also, It may be done in one stating, thus:

C.	s.	C.
If 32	12	78
56 Miles.		94 Miles.
192		312
160		702
1792		7332
		12
	s. d.	
1792	87984(49	1
	7168	or
		l. s. d.
	16304	2 9 1
	16128	
	176	
	12	
1792	2112	11
	1792	
	320	

[39]

(Ex. 2d.) How many men must be employ'd to reap 420 Acres in 17 days, if there were required 37 men to reap 54 Acres in 5 days?

	Acres.	Men.	Acres.
First, If	54	37	420
			37
			2940
			1260
Then, If	Days.	Men.	Days.
	5	287	17
		5	
			54
			15540
			108
			474
			432
			420
			378
			42
Ans. 84 Men.		7	

Note. If you would work such questions of the *Double Rule of Three*, as have one of their proportions indirect, be one stating; you must multiply the third number of your stating, by that number you would otherwise have placed under your first; and your first number by that you would have placed under the third; as in the following Example.

EXAMPLE.

Acres.	Men.	Acres.	} The number of days which have relation to the 54 Acres.
If 54	37	420	
*17		5	
378		2100	
54		37	
918		14700	
		6300	
*The number of days which have relation to the 420 Acres.		Men.	
	918	77700	(84 answer as before.
		7344	
		4260	
		3672	
		588	

Dr. Harris, in his *Lexicon Technicum*, teaches another way of ranging the five Numbers given in a *Double Rule of Three Question*; which, according to the following Rules, gives the solution, whether the proportion be direct or indirect. Take his method in his own words:

I. " Observing, that the given terms are always five, whereof three are conditional and antecedent, or supposititious, the other two demand the question, and are consequents answering some of the former antecedents; insomuch, that with the answer, there will be as many consequents as antecedents, which must match one another in the same denomination exactly.

II. " For the right placing of the question and terms, the three terms of the conditional part are duly to be regarded: Let that which is the principal Cause of Loss and Gain, Increase or Decrease, Action or Passion, be put in the first Place; and that which betokeneth the space of
" time,

" time, distance of place, &c. be put in the second
 " place; and the remaining part in the third. The
 " conditional part thus stated, the other two terms,
 " wherein the demand lies, must be placed so under
 " the former terms, that they may correspond one
 " with another.

R U L E 1.

" Then, if the blank, or place sought, fall under
 " the third term, multiply the three last terms for a
 " Dividend, and the two first for a Divisor; and the
 " Quotient gives the sixth term required.

R U L E 2.

" But if the blank fall under the first or second
 " term, multiply the 1st, 2d, and 5th terms for a
 " dividend, and the 3d and 4th for a Divisor: The
 " Quotient gives the Answer.

E X A M P L E 1.

" If 12 Rods of ditching be done by 2 men in 6
 " days, how many Rods shall be wrought by 8 men
 " in 24 days?

Answer, 192.

The numbers being stated as before directed, they
 will stand thus, the blank falling under the third
 place.

<i>Men.</i>	<i>Days.</i>	<i>Rods.</i>
2	6	12
8	24	

Therefore, by the first Rule, the three last terms,
viz. 12, 8, and 24, being multiply'd into each other,
 give 2304 for a Dividend; and the two first terms,
 C 3 *viz.*

viz. 2 and 6, multiply'd together, give 12 for a Divisor, which quotes 192, the answer.

EXAMPLE 2.

If 2 men work 12 Rods in 6 days, how many men will work 192 Rods in 24 days?

<i>Men.</i>	<i>Days.</i>	<i>Rods.</i>
2	6	12
	24	192

Here, according to the second Rule, the first, second, and fifth terms multiply'd, give 2304, which divided by 288, the product of the third and fourth numbers, quotes 8 the answer.

More **EXAMPLES.**

If 400 pecks of Corn will serve 32 horses 108 days, what quantity will 500 horses eat in 20 days?

Answer, 1157 pecks, $\frac{1}{2}$.

If 56 gallons of Drink serve 25 persons 120 days, how long will 200 gallons serve 12 persons?

Answer, 892 days.





CHAP. IV.

Of PRACTICE, and TRET and TARE.

BY PRACTICE, Merchants compendiously cast up the price of their Commodities.

And by TRET and TARE, deduct their Allowances.

Both these Rules will be best explain'd by Examples; and both require the perfect knowledge of the following

TABLE.

Of a Pound.		Of a Shilling.		Of a Ton.	
s.	d.	s.	d.	C.	
The even Parts	1	0	2	2	1 1/2
	1	8	1 1/2	2 1/2	1 1/2
	2	0	1 1/2	4	1 1/2
	2	6	1 1/2	5	1 1/2
	3	4	1 1/2	10	1 1/2
	4	0	1 1/2	Of a Hund.	
	5	0	1 1/2	lb.	
	6	8	1 1/2	14	1 1/2
	10	0	1 1/2	16	1 1/2
				Of 1/2 C.	
Of a Penny.		Of a Shilling.		Of a Ton.	
Far.		s.	d.	C.	
The even Parts		1	1 1/2	2	1 1/2
		1 1/2	1 1/2	2 1/2	1 1/2
		2	1 1/2	4	1 1/2
		3	1 1/2	5	1 1/2
		4	1 1/2	10	1 1/2
		6	1 1/2	Of a Hund.	
		Of a Penny.		lb.	
		Far.		14	1 1/2
		1	1 1/2	16	1 1/2
		2	1 1/2	Of 1/2 C.	
				lb.	
				7	1 1/2
				8	1 1/2
				14	1 1/2

Before we proceed to the rules of Practice, it will be proper to shew the manner of multiplying and dividing numbers of several denominations, by a single figure, without Reduction.

Example of MULTIPLICATION.

$$\begin{array}{r}
 \text{Multiply} \quad \begin{array}{ccc} \text{l.} & \text{s.} & \text{d.} \\ 5 & 8 & 4 \end{array} \text{ by } 8. \\
 \hline
 \text{facit } 43 \quad 6 \quad 8
 \end{array}$$

Here, first, the 4 d. multiply'd by 8, gives 32 d. equal to 2 s. 8 d. therefore setting down 8 in the place of pence, we carry 2 to the produce of the shillings. Again, 8 times 8 s. being 64 s. and the 2 carry'd making it 66 s. or 3 l. 6 s. the 6 is set down in the place of shillings, and the 3 carry'd on to the Produce of the Pounds. Lastly, 8 times 5 l. being 40 l. and the 3 carry'd making 43 l. the whole product appears to be 43 l. 6 s. 8 d.

Example of DIVISION.

$$\begin{array}{r}
 \text{Divide} \quad \begin{array}{ccc} \text{l.} & \text{s.} & \text{d.} \\ 43 & 6 & 8 \end{array} \text{ by } 8 \\
 \begin{array}{r} 8 \overline{)43 \quad 6 \quad 8} \\ \hline \text{facit } 5 \quad 8 \quad 4 \end{array}
 \end{array}$$

In dividing the above sum, we find, first, that 8 will go 5 times in 43 l. and that 3 will remain; therefore setting down 5 in the place of pounds, we multiply the said remainder by 20, and taking in the 6 odd shillings, the produce is 66 s. in which again, the divisor going 8 times, and 2 remaining, we set down 8 in the place of shillings, and multiply the 2 remaining by 12, which, with the 8 odd pence

pence taken in, produces 32 *d.* in which, lastly, the Divisor 8 going exactly 4 times, 4 is set in the place of pence, and the whole Quotient will be found to be 5 *l.* 8 *s.* 4 *d.*

Rules of PRACTICE, with Examples.

1. When the price is such a number of pence as make an even part of a shilling, divide the quantity of goods by such part, and the quotient will be the answer in shillings.

E X A M P L E.

Suppose you would know the price of 5296 ounces of Gum, at 6 *d.* per ounce; then

$$\begin{array}{r} 6 \text{ d. being } \frac{1}{2} \} 5296 \\ \text{of a Shilling, } \} \hline 2648 \text{ shillings is the Answer.} \end{array}$$

For were the price 12 *d.* or 1 *s.* the number of ounces would be the number of shillings they would cost: Therefore the price being 6 *d.* the $\frac{1}{2}$ of a shilling, the answer must be but $\frac{1}{2}$ so many shillings. So at 1 *d.* 1 *d.* $\frac{1}{2}$, 2 *d.* 3 *d.* or 4 *d.* 'tis but the $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, or $\frac{3}{4}$ parts of the quantity of goods, and the quotient (as aforesaid) will be the answer in shillings; which divided by 20, gives the pounds.

Note, If any thing remains in dividing by the said parts, (pence being the next denomination) it must be multiply'd by 12, the pence in 1 shilling; and the product divided again by the said part; and if any thing remains there, it must be multiply'd by 4, and still divided by the said part, to produce farthings.

EXAMPLE.

$$\begin{array}{r}
 \text{oz.} \quad d. \\
 5243 \text{ at } 1 \frac{1}{2} \text{ per Ounce.} \\
 \hline
 d. \quad 1 \frac{1}{2} \frac{1}{2} \quad 65 | 5 \quad 4 \frac{1}{2} \\
 \hline
 32 \text{ l. } 15 \text{ s. } 4 \text{ d. } \frac{1}{2} \text{ facit.}
 \end{array}$$

2. If the pence of the price are not an even part of a shilling, it will require more than one division, to find the cost of the goods. Thus at 5 d. or any other number of pence between 6 and 12.

EXAMPLES.

lb.	d.	lb.	d.
527	at 5 per lb.	436	at 9 per lb.
d. <u> </u>		d. <u> </u>	
4 $\frac{1}{2}$ 175 8		6 $\frac{1}{2}$ 218	
1 $\frac{1}{2}$ 43 11		3 $\frac{1}{2}$ 109	
<u> </u>		<u> </u>	
21 9 7		32 7	
<u> </u>		<u> </u>	
10 l. 19 s. 7 d. facit.		16 l. 7 s. facit.	

In the first of these, 5 d. is taken, thus: 4 d. is the $\frac{2}{3}$ of a shilling, or the top line, and 1 d. the $\frac{1}{3}$ of 4 pence.

In the second, the $\frac{1}{2}$ of a shilling is first taken for 6 d. and then the $\frac{1}{2}$ of that 6 d. for 3 d.

3. If the price is both pence and farthings; for the pence, as before; and for the farthings, take the even parts of a penny: thus.

EXAMPLE

EXAMPLE.

	oz.	d.
	532	at $1\frac{1}{4}$ per Ounce.
1 Penny, $2\frac{1}{2}$	44	4
1 Farthing, $\frac{1}{4}$	11	1
	519	5
2 L. 15 s. 5 d. facit.		

4. When the price is more than 1 s. and less than 2 s. leave the top line for the shilling, and take your parts, as before, for the remaining pence.

EXAMPLE.

d.	lb.	d.
	5437	at 19 per lb.
6 $\frac{1}{2}$	2718	6
1 $\frac{1}{2}$ $\frac{1}{4}$	679	7 $\frac{1}{2}$
	883	5 1 $\frac{1}{2}$
441 L. 15 s. 1 $\frac{1}{2}$ facit.		

5. If the price is two or more shillings, with pence, &c. either take the even parts of a pound from your top line for the shillings, which will give you the price in pounds; or multiply your top line by the number of shillings, which will give the answer in shillings, still working for the pence as before. See both ways in the example.

EXAMPLE.

oz. s. d.	oz. s. d.
5263 at 2 6 per Ounce.	5263 at 2 6 per Ounce.
s. d. ———	2
2 6½ 657 17 6	—————
	d. 10526
	6½ 2631 6
	—————
	13157 6
	—————
	657 l. 17 s. 6 d. facit.

By the first way, it is thus done: Had the price been 1 l. or 20 s. 'tis plain it would have come to as many pounds as there were ounces; therefore at 2 s. 6 d. which is the $\frac{1}{4}$ of a pound, it must come to the $\frac{1}{4}$ of so much money.

The other is done by supposing the top line at 1 s. then for 2 s. it must be twice so much; and for the 6 d. half the top line, or the value of a shilling, must be added. See both ways in another

EXAMPLE.

lb. s. d.	lb. s. d.
5276 at 19 9 per lb.	5276 at 19 9 per lb.
s. ———	19
10½ 2638	—————
5½ 1319	47484
4½ 1055 4	d. 5276
6d.½ 131 18	6½ 2638
3½ 65 19	3½ 1319
—————	—————
5210 l. 1 s. facit.	10420 1
	—————
	5210 1 s. facit.

6. When

6. When the price is any thing between one and two pounds, leave the top line for the pound, and take your parts for the remainder.

EXAMPLE.

	lb.	s.	d.
s. d.	5384	at 22	6 per lb.
2	6 $\frac{1}{2}$	673	
	6057 l. facit.		

7. When the price is two or more pounds, multiply the top line by the number of pounds; and for the remainder, take parts, as before.

EXAMPLE.

	lb.	l.	s.	d.
	2364	at 4	18	10 $\frac{1}{2}$ per lb.
	4			
s.	9456			
10 $\frac{1}{2}$	1182			
5 $\frac{1}{2}$	591			
2 $\frac{1}{2}$	236	8		
1 $\frac{1}{2}$	118	4		
6d. $\frac{1}{2}$	59	2		
3 $\frac{1}{2}$	29	11		
1 $\frac{1}{2}$ $\frac{1}{2}$	14	15	6	
	11687 l. 00 s. 6 d. facit.			

8. When with the given quantity there are odd parts, such parts must be taken from the given price; as in the following examples.

EXAMPLES.

EXAMPLES.

	C.	qrs.	l.	s.
	365	2	at 5	5 per C.
	5			
s.	1825			
5	$\frac{1}{2}$	91	5	
2 qrs. $\frac{1}{2}$		2	12	6
	1918	l.	17 s.	6 d. facit.

	C.	qrs.	lb.	l.	s.	d.
	7365	3	14	at 8	19	6 per C.
	8					
s.	58920					
10	$\frac{1}{2}$	-3682	10			
5	$\frac{1}{2}$	-1841	5			
4	$\frac{1}{2}$	-1473	0			
6 d.	$\frac{1}{2}$	-184	2	6		
2 qrs.	$\frac{1}{2}$	—4	9	9		
1	$\frac{1}{2}$	—2	4	10	$\frac{1}{2}$	
14 lb.	$\frac{1}{2}$	—1	2	5	$\frac{1}{4}$	
	66108	l.	14 s.	6 d.	$\frac{1}{4}$	facit.

As in the first of these, for the 2 qrs. $\frac{1}{2}$ the price of the C. is taken; so in the second, not only $\frac{1}{2}$ the price of the C. is taken for 2 qrs. but also $\frac{1}{2}$ the price of 2 qrs. for 1 qr. and $\frac{1}{2}$ that again for 14 lb. See more Examples.

EXAMPLES.

[51]

EXAMPLES.

Tons. C. qrs. lb. l. s. d.
 573 13 2 18 at 9 12 10 per Ton.
 9

	5157		
10 s.	$\frac{1}{2}$ —286	10	
2	$\frac{1}{2}$ —57	06	
10 d.	$1\frac{1}{2}$ —23	17	6
10 C.	$\frac{1}{2}$ —4	16	5
2	$\frac{1}{2}$ —19	3	$\frac{1}{2}$
1	$\frac{1}{2}$ —09	7	$\frac{1}{2}$
2 qrs.	$\frac{1}{2}$ —04	9	$\frac{1}{2}$
14 lb.	$\frac{1}{2}$ —01	2	$\frac{1}{2}$
2	$\frac{1}{2}$ —	2	
2	$\frac{1}{2}$ —	2	

5531 l. 5 s. 1 d. $\frac{1}{2}$

lb. oz. dr. l. s. d.
 527 13 15 at 2 8 7 $\frac{1}{2}$ per lb.
 2

	1054		
5 s.	$\frac{1}{2}$ —131	15	
2	$1\frac{1}{2}$ —52	14	
1	$\frac{1}{2}$ —26	07	
6 d.	$\frac{1}{2}$ —13	03	06
$1\frac{1}{2}$	$\frac{1}{2}$ —3	05	$10\frac{1}{2}$
8 oz.	$\frac{1}{2}$ —1	04	$03\frac{1}{2}$
4	$\frac{1}{2}$ —	12	$01\frac{1}{2}$
1	$\frac{1}{2}$ —	03	$00\frac{1}{2}$
8 drs.	$\frac{1}{2}$ —	01	06
4	$\frac{1}{2}$ —		09
2	$\frac{1}{2}$ —		$04\frac{1}{2}$
1	$\frac{1}{2}$ —		$02\frac{1}{2}$

1283 l. 7 s. 8 d. facit.

The

The last Sum another way.

lb. oz. drachms. l. s. d.

527 13 15 at 2 8 7 $\frac{1}{2}$ per lb
48

				4216	
				2108	
6	l.	—	—	263	6
1	$\frac{1}{2}$	—	—	65	10 $\frac{1}{2}$
8	oz.	—	—	24	3 $\frac{1}{2}$
4		—	—	12	1 $\frac{1}{2}$
1		—	—	3	c $\frac{1}{2}$
8	dr.	—	—	1	6 —
4		—	—		9 —
2		—	—		4 $\frac{1}{2}$
1		—	—		2 $\frac{1}{2}$

2566 | 7 8

1283 l. 7 s. 8 d. facit.

Another EXAMPLE.

lb. Troy. oz. dwts. grs. l. s. d.

736 11 12 13 at 23 16 4 per lb.
23

				2208	
				1472	
10	s.	—	—	368	
5		—	—	184	
1		—	—	36	16
4	d.	—	—	12	5 4
6	oz.	—	—	11	18 2
4		—	—	7	18 9 $\frac{1}{2}$
1		—	—	1	19 8 $\frac{1}{2}$
10	dwts.	—	—		19 10
2		—	—		3 11 $\frac{1}{2}$
12	grs.	—	—		11 $\frac{1}{2}$
1		—	—		1 $\frac{1}{2}$

17552 l. 2 s. 9 d. $\frac{1}{2}$ facit.

Note,

Note. The foregoing examples, and all other questions in *Practice*, may be performed by the *Rule of Three*; *Practice* being only a compendious way of calculating such propositions in proportion, as have an unit for their first number: But to shew the brevity of this way of working, as well as to prove the truth thereof; see the last example done by the *Rule of Three*, as follows.

By the *Rule of Three* thus:

lb.	l.	s.	d.	lb.	oz.	dwt.	grs.
If 1—cost—23	16	4	what will	736	11	12	13?
12	20			12			
12	476			8843			
20	12			20			
240	5716			176872			
24				24			
960				707491			
480				353745			
5760				4244941			
				5716			
				37469646			
				4244941			
				29714587			
				21224705	12		
				576102426408275	614212514	10	
				1224	2103510412		
				720	175522	102	
Facit 175521	22	10	d. 1/4	1448			
				2962			
Three Farthings more				827			
than by <i>Practice</i> lost				2515			
there by the <i>Fractions</i>				2116			
remaining.				4			
				57610284614			
				270			

PROOF.

PROOF.

Sums in this rule may be proved either by taking the parts two ways, as the last example but one; or by the *Rule of Three*, as the last.

ABBREVIATIONS.

As this whole rule is indeed nothing else, it may be thought strange to mention short ways here, in a particular section; but as there are degrees of comparison, so even short ways may be more shorten'd.

1. The value of any quantity (the given price of one of which is an even number of shillings) may be most compendiously found, by multiplying the said quantity by $\frac{1}{2}$ their number, doubling the units of the first product for shillings, the rest being pounds.

EXAMPLE.

5276 Ells of Holland at 8s. per Ell.

$$\begin{array}{r} 4 \\ \hline 2110:8 \text{ Answer.} \end{array}$$

2. If the price is an odd number of shillings, it is but doing as before, and adding $\frac{1}{2}$ of the top line to the product.

EXAMPLE.

Yards. s.
5278 at 15 per Yard.

$$\begin{array}{r} 7 \\ \hline 3694: 12 \\ 263: 18 \\ \hline 3958l. 10s. \text{ Answer.} \end{array}$$

3. Were

3. Were there pence in the price, their parts might also easily be taken in the same method.

EXAMPLE.

$$\begin{array}{r}
 \text{lb.} \quad \text{s.} \quad \text{d.} \\
 5384 \text{ at } 7 \text{ } 7 \frac{1}{2} \text{ per lb.} \\
 \underline{3} \\
 1615 \quad 4 \\
 1 \text{ s. } 28 \quad 269 \quad 4 \\
 6 \text{ d. } \frac{1}{2} \quad 134 \quad 12 \\
 1 \frac{1}{2} \quad 33 \quad 13 \\
 \hline
 4051 \text{ l. } 13 \text{ s. facit.}
 \end{array}$$

4. Another short and useful way, when the quantity is small, is to multiply the price by it; thus, if your quantity is expressed by one figure, 'tis done by one line.

EXAMPLE.

$$\begin{array}{r}
 \text{l.} \quad \text{s.} \quad \text{d.} \\
 5 \text{ Bush of Wheat, at } 1 \text{ } 13 \text{ } 6 \text{ per Bush} \\
 \underline{5} \\
 8 \text{ l. } 7 \text{ s. } 6 \text{ d. facit.}
 \end{array}$$

5. So any quantity that can be expressed by 2 figures, and some of 3, may be easily and speedily done thus: Find out what two figures, multiply'd together, will produce the given quantity, (as suppose 32 yards or pounds, &c. the given quantity which is produced by the multiplication of 8 by 4) and multiply the price by one of the said figures; and the product of that, multiply'd again by the other, will give the answer.

EXAMPLES.

EXAMPLES.

Yards. s. d.
32 at 15 8½ per Yard.
8

The value of 8 yards, 6 5 8—
which multiply'd by 4

gives 25l. 2s. 8d. the price of 32 yards,
—4 times 8 being 32.

Yards. l. s. d.
144 at 1 5 6 per Yard.
12

15 6 0
12

183 l. 12s. 0d. each.

6. If no two figures will exactly produce those given, take such as will give the nearest product to them, which will generally be within one or two, more or less; the value of which must accordingly be added or subtracted.

EXAMPLE.

lb. l. s. d.
55 at 1 10 9 per lb.
9

The price of 9 lb. 13 16 9
which multiply'd by 6

gives the price of 54 lb. 83 00 6
to which the price of 1 lb. added 1 10 9

makes 84 11 3 the value of 55-
So,

So, had it been multiply'd by 7 and 8, which would have given the value of 56 lb. too much by 1 lb. the price of 1 lb. must have been subtracted.

7. If the quantity has odd parts, it will be easy taking the value of such parts from the given price; as in the following

EXAMPLE.

<i>Yds.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>	
43 $\frac{1}{2}$	at	2	12	7 per Yard.
			7	
		18	8	1
				6
		110	8	6
<i>grs.</i>		2	12	7
2 $\frac{1}{2}$		1	6	3 $\frac{1}{2}$
		114	l. 7	s. 4 $\frac{1}{2}$ facit.

TRETT and TARE.

TARE and **TRETT** are allowances made to Merchants in buying their goods.

Tare, of what they can agree for *per* the whole, *per* chest, &c. or *per* C. for the weight of the bag, box, chest, &c. which contains the commodity.

Trett, for the waste, motes, or dust; and is always $\frac{1}{4}$ lb. *per* 104 lb.

There is also another allowance sometimes given of $\frac{1}{2}$ lb. for every 3 C. for the turn of the scale, call'd *cloff*, or *clough*.

Note, The whole weight, before any allowances are made, is call'd *gross*; when part is deducted, the remainder is call'd *nettle*; but when all are taken from it, what's left, is call'd *net*.

RULES,

RULES, with EXAMPLES.

1. The *Tare* of any quantity of goods may easily be found, if at so much in the whole, only by subtracting the said allowance from the gross weight; if at so much *per chest*, &c. by multiplying the pounds tare by the number of chests, &c. and subtracting as before; and if at so much *per C.* by taking such part or parts of the gross weight, as the allowance is of a C.

EXAMPLES.

First sort. Suppose 15 C. 2 qrs. 13 lb. tare were allowed on 456 C. 1 qr. 19 lb. of tobacco, what would be the neat weight?

	C.	qrs.	lb.	
From	456	1	19	Gross.
Subtract	15	2	13	Tare.

Remainder 440 3 6 Neat.

Second sort. What's the neat weight of 3 frails of raisins, each weighing 3 C. 2 qrs. 10 lb. gross; tare at 20 lb. *per* frail?

C.	qrs.	lb.		lb.
3	2	10		20
		3 Frails.		3 Frails.
10	3	2 Gross.		60 lb. or 2 qrs. 4 lb.
		2 4 Tare.		

Answer, 10 0 26 Neat.

	C.	qrs.	lb.		lb.
Third sort.	246	3	12	Gross.	
					Tare 14 <i>per</i> C.
	14	$\frac{1}{2}$			
		30	3	12	Tare.

Answer, 216 0 0 Neat.

Again,

	C.	qrs.	lb.		lb.
Again,	364	1	19	Gross.	Tare 16 per C.
lb.					
	16	7	52	0	6 1/2 Tare.

Answer, 312 1 12 1/2 Neat.

Note, 14 and 16 pounds may be call'd the standards of Tare; for from them may any other number of pounds, more or less, be taken, as in the following

EXAMPLES.

	C.	qrs.	lb.		
	573	2	13	Gross.	
lb.					
	14	7	1	2	22 1/2
	2	7	10	0	27 —
	1	4	5	0	13 1/2
	8	7	0	7	Tare.

Answer, 486 2 6 Neat.

	C.	qrs.	lb.		lb.
	545	3	11	Gross.	Tare 10 per C.
lb.					
	16	7	8	1	17 1/2
	8	1	3	9	22 1/2
	2	4	9	3	5 1/2
	4	9	0	0	1/4 Tare.

Answer, 499 3 10 1/4 Neat.

Note, 'Tis first found what Tare 16 lb. would produce; because 8 lb. being the 1/2 part of a C. would be a troublesome divisor.

2. *Trett* being always 4 lb. per 104 lb. the constant method of finding it, is by taking the $\frac{1}{26}$ part of the line it is to be deducted from, 4 times 26 being 104. But it being difficult to divide by 26 in one line, it will be more safe and easy to do the work aside, as in the first Example.

EXAMPLES.

C. grs. lb.		lb.	
428	1 19	Gross.	<i>Trett</i> 4 per 104
lb.			
4 2 $\frac{1}{2}$	16 1 25 $\frac{1}{2}$	<i>Trett.</i>	26)428(16
<i>Facit</i>	411 3 21 $\frac{1}{2}$	<i>Nett.</i>	168
			12
			4
			26)49(1
			23
			28
			193
			47
			26)663(25
			143
			13
			4
			26)52(2
			0

C. gr. lb.		lb.	
836	2 17	Gross, Two 22 per C.	
		Trett, 4 lb. per 100 lb.	
lb.			
16 $\frac{1}{2}$	119 2 2 $\frac{1}{2}$		
4 $\frac{1}{2}$	29 3 14 $\frac{1}{2}$		
2 $\frac{1}{2}$	14 3 21 $\frac{1}{2}$		
	164 1 10	Tare.	
	672 1 7	Nett.	
lb.			
4 $\frac{1}{2}$	25 3 12	Trett.	
facit	646 1 23	Nett.	

3. *Clough* (which is always 2 lb. for 3 C.) may be found by taking the $\frac{1}{15}$ part of the line it is to be deducted from, 2 lb. being the $\frac{1}{15}$ part of 336 lb. or 3 C. But let the work be done aside, as directed in finding the trett. Or the allowance for *Clough* may be found, by first dividing the hundreds of the line it is to be taken from, by 3, which brings them into 3 Cs; then 2 lb. being to be allow'd for every 3 C. as many 3 Cs as it produces, so many 2 lb's it will allow; then dividing by 56, (the double pounds in a hundred) the quotient will be hundreds, and the remainder double pounds; to which adding, what may be allow'd for the odd hundreds, quarters, and pounds of the given weight, it makes the whole *Clough*; which subtracted from the said given weight, leaves the *Nett*. See both ways in the first Example.

D

EXAMPLE

[62]

EXAMPLE

What will be the Nept. weight of 5647 C. 3 qrs. 13 lb. Gross, allowing for Clough 2 lb. for 3 C.

C.	qrs.	lb.	
5647	3	13	Gross.
33	2	13	Clough.
5614	1	00	Net.

C.
168)5647(33

• 607

103

168)413(2

• 79

28

635

259

168)2225(13

• 245

• 41

33)5647(1

36)1882(33

14)24(2

• 6

Note, The remainder 34 (which are double pounds) is divided by 14, the double pounds in a qr. to bring the said remainder into quarters of an hundred, making 2 qrs. and 12 lb. And 1 lb. being allow'd for the old C. 3 qrs. and 13 lb. the whole makes, as before, 33 C. 2 qrs. 13 lb.

EXAM

EXAMPLE 2.

What is the weight of 3 hundred 43 lbs. weighing, etc.

Number, C. qrs. lb.

1—5 3 48

2—4 2 11

3—5 1 39

15 3 20

lb. 14 1/2 3 27 1/2

7 1/2 3 27 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

14 3 20 1/2

4 1/2 2 8 1/2

There 7 lb. per C.
There 4 lb. per 104 lb.
Clough 2 lb. for 3 C.

14 3 20 1/2 Saddle.

4 1/2 2 8 1/2 Dress.

14 3 20 1/2 Saddle.

9 1/2 Clough.

3)14(4

Def. 14 1/2 2 8 1/2

2

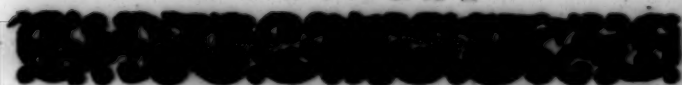
lb.

Note, The 4 three hundreds allow ———8.

And the odd 2 C. 104 lb. 1/2 allow ———1/2

Total Clough 9 1/2





CHAP. V.

Of INTEREST.

INTEREST is either $\left\{ \begin{array}{l} \text{Simple,} \\ \text{Or} \\ \text{Compound,} \end{array} \right. \left\{ \begin{array}{l} \text{which arises only from} \\ \text{the Principal.} \\ \text{which arises both from} \\ \text{Principal and Interest.} \end{array} \right.$

SIMPLE INTEREST.

SIMPLE INTEREST being one of the branches of Proportion, or the *Rule of Three*, is work'd as follows.

1. The Interest of any Sum for one year is found by this plain proportion, viz.

As 100*l*,
To the rate of Interest:
So is the given Principal,
To the Interest required.

EXAMPLE

What's the Interest of 429*l*. for a year, at 6*l*. per Cent. per Annum?

$\begin{array}{r} \text{£} \quad \text{£} \quad \text{£} \\ \text{If } 100 \text{ --- } 6 \text{ --- } 429 \\ \phantom{\text{If } 100 \text{ --- } 6 \text{ --- } } 6 \end{array}$

Facit 25 £. 14 s. 9 d. $\frac{1}{2}$.

$$\begin{array}{r}
 25 \overline{) 74} \\
 \underline{20} \\
 14 \overline{) 80} \\
 \underline{12} \\
 9 \overline{) 60} \\
 \underline{4} \\
 2 \overline{) 40}
 \end{array}$$

Now, The cutting off two figures to the right-hand, divides each line by 100. See *Abbreviations of Division*.

2. To find the interest of any sum for 2 or more years, multiply the year's amount by the number of years required.

EXAMPLE.

What interest will the foregoing principal produce in 4 years, at the same rate of interest?

$\begin{array}{r} \text{£} \quad \text{s.} \quad \text{d.} \\ 25 \quad 14 \quad 9 \frac{1}{2} \text{ the interest for one year.} \\ \phantom{25 \quad 14 \quad 9 \frac{1}{2} \text{ the interest for one year.}} 4 \\ \hline \end{array}$

Facit 102 19 2

3. To find interest for months, divide the year's amount by the even-parts they make of a year.

EXAMPLE.

What's the interest of 572 l. for 8 months, at 5 l. per Cent. per Annum?

l.	l.	s.	d.
If 100 —	572 —	28	12
	03 15	14	6
	— 28 60	4	15 4
	03 30		
	— 10 00		
		19 l. 1 s. 4 d. facit.	

4. If the time is weeks or days, instead of taking the even parts of a year, as the months, it must be done by a second-finding in the Rule of Three.

EXAMPLE.

Ex. 1. What's the interest of 321 l. 16 s. 8 d. for 3 weeks, at 6 l. per Cent. per Annum?

l.	s.	d.
If 100 —	321	16 8
	19 21	00
	20	
	6 30	
	12	
	3 10	
	4	
	1 60	

Facit 19 l. 6 s. 2 d. 1/2 for a Year.

Then.

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Then, If 52 — 19 6 2 1/2 — 3

20
 386
 12
 4634
 4
 18537
 3 4
 52)55611(1069(1
 52
 12)267(3
 361
 312 2 1/2
 1 l. 2 s. 3 d. 1/2 facit.
 491
 468
 23

Ex. 2. What interest is now due on a bond of 420 l. 10 s. commencing interest at 5 l. 10 s. per Cent. per Annum. July the 10th 1737: this being March the 25th 1729?

l. s. l. s.
 If 100 — 5 10 — 420 10
 5
 s. 2102 10
 10 1/2 210 5
 23)12 15
 20
 23 l. 2 s. 6 d. 1/2
 for a Year. 2 55
 12
 6 60
 4
 2 40

July 21
 August 31
 September 30
 October 31
 November 30
 December 31
 January 31
 February 28
 March 25
 258

D 4

Then,

[68]

Then, If $\begin{matrix} \text{Days.} & l. & s. & d. \\ 365 & -23 & 2 & 6\frac{1}{2} \end{matrix}$ Days. $\begin{matrix} 258 \end{matrix}$

20

462

12

5550

4

22202

258

177616

111010

44404

4

365)5728116(15693(1

365

12(3913(11

2078

1825

2103216

2531

2190

16 l. 6 s. 11 d. $\frac{1}{2}$ for 258 days.

23 l. 2 s. 6 d. $\frac{1}{2}$ for 258 days.

3411

3285

39 l. 9 s. 5 d. $\frac{1}{4}$ total Interest.

1266

1095

171

Another way to cast up Interest, when the principal has odd money in it, and the time, weeks or days.

R U L E.

Bring your principal into its lowest denomination, and multiply it by the number of days; and if at 5 l. per

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per Cent. divide the product by 7300, the quotient gives the answer in the same denomination the principal was reduced into. Also, The number 7300 is found by multiplying 365 by 100, and dividing by 5.

EXAMPLES.

What's the interest of 432*l.* 12*s.* 6*d.* for 8 days, at 5*l.* per Cent. per Annum?

$$\begin{array}{r}
 \begin{array}{r}
 \textit{l. s. d.} \\
 432 \ 12 \ 6 \\
 \hline
 20 \\
 \hline
 8652 \\
 12 \\
 \hline
 103830 \\
 8 \ 12 \\
 \hline
 73|00)8306|40(113 \\
 \underline{73} \qquad \qquad \qquad 9 \textit{s. } 5 \textit{d. } \frac{1}{2} \textit{farth.} \\
 100 \\
 \underline{73} \\
 276 \\
 \underline{219} \\
 5740 \\
 \underline{4} \\
 73|00)119|60(3 \\
 \underline{219} \\
 10
 \end{array}
 \end{array}$$

If you would cast up Interest at 6*l.* per Cent. by this rule, you must add $\frac{1}{4}$ of the quotient to the interest produced at 5*l.* per Cent. and so at other rates.

D 5

it

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it is but adding or subtracting such and such parts of the quotient to or from what is produced at 72. For instance, suppose the last question done the common way, for the time 175 202 202 202 202 202

EXAMPLE.

$$\begin{array}{r}
 \begin{array}{r}
 L. \\
 420 \\
 20 \\
 \hline
 8410 \\
 623 \text{ number of days.} \\
 \hline
 25230 \\
 16820 \\
 \hline
 50460
 \end{array}
 \end{array}$$

$$\begin{array}{r}
 73|00(52934|30(717 \ 84 \\
 511 \ 2. \\
 \hline
 1017 \ 71 \ 94 \\
 : 129 \ 78|9 \ 6 \\
 73 \ 39 \ 9 \ 6 \text{ Answer, I forbidding more} \\
 : 564 \ 1. \text{ than by the other way.} \\
 511 \\
 \hline
 5330 \\
 12 \\
 \hline
 73|00(639|60(8 \\
 584 \\
 \hline
 5560 \\
 4 \\
 \hline
 73|00(222|40(3 \\
 219 \\
 \hline
 940
 \end{array}$$

Note. The Rate here being 5 l. 10 s. and 10 s. being 10 of 5 l. there is therefore added 10 of the quarters, or the amount, at 5 l. 10 s.

More Examples in Simple Interest.

At 6 l. per Cent. what will 589 l. come to in a year?

Answer, 35 l. 6 s. 9 d. 1/2.

What will the same sum, at the same rate, amount to in 8 years?

Answer, 282 l. 14 s. 4 d.

What's the interest of 7020 l. for 5 months, at 5 l. per Cent. per Annum?

Answer, 146 l. 5 s.

What's a week's interest of 1000 l. at 7 l. per Cent.?

Answer, 1 l. 6 s. 11 d.

What will the interest of 5429 l. 10 s. 8 d. come to in 20 days, at 5 l. per Cent.?

Answer, 14 l. 17 s. 6 d.

What Interest is now due on a Navy-bill, commencing interest at 6 l. per Cent. per Annum, June the 4th 1733, this being January the 10th 1735, the principal being 836 l.?

Answer, 8 l. 7 s. 10 d.

Compound INTEREST.

COMPOUND INTEREST, as was before said, arises both from the principal and interest; (i.e.) when interest on money becoming due, and not paid, the same rate is allow'd on the unpaid interest, as was before on the principal.

Therefore, to work sums in this rule, after having found the first year's interest, as before, add it to the principal, and find the interest of the sum; and so continue to add every year's produce, till accounting the sum a new principal.

EXAMPLE.

What will be the amount of 400 l. forborn 3 years and $\frac{1}{2}$, at 6 l. per Cent. per Annum, compound Interest?

$\begin{array}{ccc} \text{l.} & \text{l.} & \text{l.} \\ \text{If } 100 & \text{---} 6 & \text{---} 400 \text{ Principal } 1^{\text{st}} \text{ year.} \\ & & 6 \end{array}$

$\begin{array}{r} \hline \text{l. } 24 | 00 \\ \hline \end{array}$

$\begin{array}{ccc} \text{l.} & \text{l.} & \text{l.} \\ \text{If } 100 & \text{---} 6 & \text{---} 424 \text{ Principal } 2^{\text{d}} \text{ year.} \\ & & 6 \end{array}$

$\begin{array}{r} \hline \text{l. } 25 | 44 \\ \hline 30 \end{array}$

$\begin{array}{r} \hline \text{s. } 8 | 80 \\ \hline 12 \end{array}$

$\begin{array}{r} \hline \text{d. } 9 | 60 \\ \hline 4 \end{array}$

$\begin{array}{r} \hline 2 | 40 \\ \hline \end{array}$

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L. 100 0 0

	4 ²⁴	25	8	9½	
L.	L.				
If 100	6	449	8	9½	Princip. 3 ^d year.
				6	

	L. 26	12	9	
		20		

	L. 19	32	
		12	

	L. 3	93	
		4	

3 | 72

L. s. d.

	449	8	9½	
	26	19	3½	
L.	L.			
If 100	6	476	8	1½
				6

Princip. 4th year.

	L. 28	11	8	
		20		

	L. 11	68	
		12	

	L. 8	23	
		4	

94

Or.

Or, more plain:

Interest the 1 st Year	24	0	0
2 ^d Year	24	0	0
3 ^d Year	24	0	0
4 th Year	24	0	0
5 th Year	24	0	0
Total Interest	120	0	0
Principal	400	0	0
Total amount	520	0	0

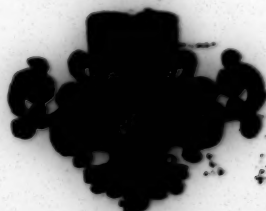
More EXAMPLES.

What will 1000 l. amount to in 3 years, at 6 l. per Cent. per Annum, Compound Interest?

Answer, 1191 l. 0 s. 3 d. $\frac{1}{2}$.

At 5 l. 10 s. per Cent. per Annum, Compound Interest, what will 560 l. 10 s. 9 d. amount to, forborn 5 years and an half?

Answer, 752 l. 14 s. 10 d. $\frac{1}{2}$.





1774. 189. 1100. 104

CHAP. VI.

Of REBATE, or DISCOUNT.

REBATE, or DISCOUNT, is the abating so much money on a debt paid before 'tis due, as might be gain'd again by the money receiv'd, if put out to interest at the same rate, and for the same time. So 100 *l.* present money, would discharge a debt of 106 *l.* due at a year to come; rebate being made at 6 *l.* per Cent. because 100 *l.* put out to interest for a year, at the said rate, would regain the 6 *l.*

To work Sums in this RULE.

First, find the interest of 100 *l.* for the time; then by a *Rule of Three* stating, of which the first number must be 100 *l.* with the interest found; the second number, the interest alone (or 100 *l.* alone, if you would find the present money); and the third, the debt, or sum propounded, you will find the answer.

EXAMPLES.

EXAMPLES

Ex. 1. What's the rebate of 420 l. for a year, at 6 l. per Cent. per Annum?

$$\begin{array}{r} \text{l.} \quad \text{l.} \quad \text{l.} \\ \text{If } 106 \text{ --- } 5 \text{ --- } 420 \\ \quad \quad \quad 6 \end{array}$$

$$\begin{array}{r} \text{---} \text{l.} \\ 106 \overline{) 2520} (23 \\ \underline{212} \end{array}$$

$$\begin{array}{r} \text{---} \\ 400 \\ \underline{318} \end{array}$$

$$\begin{array}{r} \text{---} \\ 82 \\ \underline{20} \end{array}$$

$$\text{Ans. 23 l. 15 s. 5 d. } \frac{1}{2} \quad 106 \overline{) 1640} (15$$

$$\begin{array}{r} \text{---} \\ 106 \\ \underline{580} \end{array}$$

$$\begin{array}{r} \text{---} \\ 530 \\ \underline{50} \end{array}$$

$$\begin{array}{r} \text{---} \\ 12 \end{array}$$

$$\begin{array}{r} \text{---} \text{d.} \\ 106 \overline{) 600} (5 \\ \underline{530} \end{array}$$

$$\begin{array}{r} \text{---} \\ 70 \\ \underline{4} \end{array}$$

$$\begin{array}{r} \text{---} \\ 106 \overline{) 280} (2 \\ \underline{212} \end{array}$$

$$\begin{array}{r} \text{---} \\ 68 \end{array}$$

Ex. 2.

6 Interest for a year of 100

Months — 3 1/2 1. 10

Then, If 101 is full to 100, what will 732?

Inf. 721 L 35 721

$$\begin{array}{r} 203)146400(721 \\ \underline{1431} \\ 330 \\ \underline{406} \\ 2240 \\ \underline{206} \\ 137 \\ \underline{20} \\ 203)744(3 \\ \underline{609} \\ 1351 \\ \underline{12} \\ 203)1572(7 \\ \underline{1421} \\ 151 \\ \underline{4} \\ 203)604(2 \\ \underline{406} \\ 198 \end{array}$$

Ex. 3.

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Ex. 3. What rebate must be allowed on a bill of Exchange for 87*l*. 10*s*. due September the 8th, this being July the 4th, rebate being made at 5*l*. per Cent. per Annum?

	Days.	1.	Days.
July 27	365	5	66
Aug. 31			5
Sept. 8			330
			20
66			12 d.
365) 10484 (28			365) 8600 (18 0 1
1048			365
000			2970
200			2920
000			30
000			12
72			360
02			4
365) 1440 (3			1095
1095			345

Then,

[79]

Then, $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$
 $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$
 $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$
 $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$ $1000000 \div 1000000 = 1$

24216 867 20520

4 4

96867 82080

867

574560

492480

656640

$9686771163360734(2$

678069

$12)183(3$

335646

290601

19213480

450450

387468

62982

Answer, $15 \text{ s. } 3 \text{ d. } 8$

Ex. 4. A Bill of Exchange for 250 £ is dated at Amsterdam, June the 14th, new Style; at usance is accepted, and payment offered the 15th *disco*, old Style: what must be then receiv'd, rebate being made at 6 £ per Cent. per Annum?

Note, New Style is 11 days before Old Style.

Usance signifies the usual time of payment of bills between one country and another; which between England and Holland is one month; double Usance, two months, &c. Note also, Merchants of London generally

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rally allow 3 days beyond the time appointed, calling them 3 days of grace. Therefore the bill being dated June the 14th M.S. or the 3d O.S. and accepted at usance, or a month, it becomes due July the 3d O.S. but 3 days of grace being allow'd, makes it the 6th. So if the money is paid the 15th of June O.S. rebate must be made for 21 days. Therefore,

Days.	L.	Days.
If 365	6	21
	6	
	126	
	20	
	365)2520(6	
	2190	
	330	
	12	
	365)3960(10	
	365	
	310	
	4	
	365)1240(3	
	1095	
	145	

Each 64. 10d. 4. 1/2

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L	s.	d.	L	L
100	6	10 1/2	100	250
20				20
2006				5000
12				12
24082				60000
4				4
96331				L

96331)24000000(249
192662

473380
385324

880560
866979

13581
20

96331)271620(2
192662

78958
12

96331)947496(9
866979

80517
4

96331)322068(3
288993

33075

Ans. 249 L 2 s. 9 d. 1/2

More

More: 3-4-10 P-2-2-0.

What's the rebate of 100 l. for $\frac{1}{2}$ a year, at 6 l. per Cent. per Annum?

Answer, 2 l. 18 s. 3 d.

What's the rebate of 538 l. 10 s. for 5 months, at 5 l. per Cent. per Annum?

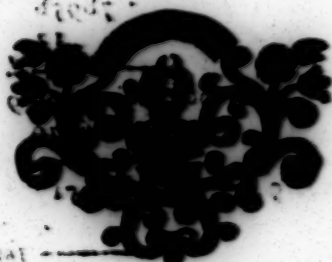
Answer, 10 l. 19 s. 9 d. $\frac{1}{2}$.

What present money is a debt of 629 l. due at 3 weeks, worth, rebate being made after the rate of 6 l. 10 s. per Cent. per Annum?

Answer, 626 l. 13 s.

What present money will discharge 10000 l. due at 5 days, rebate being made at 8 l. per Cent. per Annum?

Answer, 9989 l. 1 s. 5 d. $\frac{1}{2}$.



BOOKS

CHAP. VII.

EQUATION of PAYMENTS.

THE design of this rule is, when several sums be due at several times, to find a mean time for paying the whole debt.

The common way to do which, is,

Multiply each sum by its respective time, and add all the products together, dividing their total by the whole debt; the quotient is accounted the mean time of paying the whole debt.

EXAMPLE.

A. owes to B. 40 l. at 3 months, 60 l. at 5 months, and 100 l. at 10 months. At what time may the whole debt be paid without injury to either?

<i>l.</i>	<i>l.</i>	<i>l.</i>	<i>l.</i>
40	40	60	100
60	3	5	10
100	—	—	—
—	120	300	1000
200			300
			120

2100 | 14 | 20

Answer, 7 months.

Note,

Note, The times of payment, if not so given, must be reduced into one sum.

But those who are more exact, take the pains to work these sums by the following rule.

First, they find the present worth of every particular sum; then find in what time to come the sum of these present worths will be increased to the total of all the particular sums payable at the several times to come; and that is the true equated time for payment of the whole.



C H A P. VIII.

Of FELLOWSHIP, or COMPANY.

FELLOWSHIP, or COMPANY, is when two or more join their stocks, and trade together, dividing their gain or loss proportionably.

FELLOWSHIP is either with, or without time.
Questions without time, are work'd by this proportion.

As the whole stock,
To the whole gain, or loss:
So is each man's particular stock,
To his particular share.

E X A M P L E S.

A. B. and C. make a joint-stock; A. puts in 460 l. B. 510 l. and C. 480 l. they gain 340 l. what part of it belongs to each?

	l.
A. —————	460
B. —————	510
C. —————	480
	—
Total stock	1450

[86]

1 st . Then, If $\overset{L}{145} \overset{L}{0} - \overset{L}{340} - \overset{L}{46} 0$		
		<u>340</u>
2 ^d . If $\overset{L}{145} \overset{L}{0} - \overset{L}{340} - \overset{L}{51} 0$		<u>1840</u>
		<u>138</u>
	<u>2040</u>	<u>145) 15640 (107</u>
	<u>193</u>	<u>145</u>
	<u>145) 17340 (119</u>	<u>1140</u>
	<u>145</u>	<u>1015</u>
	<u>284</u>	<u>125</u>
	<u>145</u>	<u>20</u>
	<u>1390</u>	<u>145) 2500 (17</u>
	<u>1305</u>	<u>145</u>
	<u>85</u>	<u>1050</u>
	<u>20</u>	<u>1015</u>
	<u>145) 1700 (11</u>	<u>35</u>
	<u>145</u>	<u>12</u>
	<u>250</u>	<u>145) 420 (2</u>
	<u>145</u>	<u>290</u>
	<u>105</u>	<u>130</u>
	<u>12</u>	<u>4</u>
	<u>145) 1260 (8</u>	<u>145) 520 (3</u>
	<u>1160</u>	<u>435</u>
	<u>100</u>	<u>85</u>
	<u>4</u>	
	<u>145) 400 (2</u>	
	<u>290</u>	
	<u>110</u>	

[87]

3d. And, If $\overset{L}{145} | 0 \text{ --- } \overset{L}{340} \text{ --- } \overset{L}{48} | 0$
 $\underline{340}$

$\underline{1920}$
 $\underline{144}$ $\overset{L}{145}$
 $145) 16320 (112$
 $\underline{145}$
 $\cdot 182$
 $\underline{145}$
 $\cdot 370$
 $\underline{290}$
 $\cdot 80$
 $\underline{20}$ $\overset{s.}{145}$
 $145) 1600 (11$
 $\underline{145}$
 $\cdot 150$
 $\underline{145}$
 $\cdot 5$
 $\underline{12}$
 $\underline{60}$
 $\underline{4}$
 $145) 240 (1$
 $\underline{145}$
 $\cdot 95$

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>Rem.</i>
A's Share is	107	17	2 $\frac{1}{2}$	85
B's Share is	119	11	8 $\frac{1}{2}$	110
C's Share is	112	11	0 $\frac{1}{4}$	95
Value of the Remainder $\frac{1}{2}$				$\underline{145) 290 (2}$
The whole } gain.	340	00	0	290
				$\underline{0}$

And thus are these Sums proved.

More EXAMPLES.

Three persons make a joint-stock; *A.* puts in 565 *l.* *B.* 278 *l.* and *C.* 629 *l.* they gain 1000 *l.* and what is each of their shares?

	<i>l.</i>	<i>s.</i>	<i>d.</i>	Remainders.
<i>Answer,</i> { <i>A.</i>	383	16	7 $\frac{1}{2}$	384
{ <i>B.</i>	188	17	2	512
{ <i>C.</i>	427	6	2 $\frac{1}{2}$	576

D. *E.* and *F.* trade together; *D.* puts in 230 *l.* *E.* 529 *l.* and *F.* 344 *l.* 10 *s.* their whole gain amounts to 520 *l.* what is that to each?

	<i>l.</i>	<i>s.</i>	<i>d.</i>	Remainders.
<i>Answer,</i> { <i>D.</i>	108	7	7 $\frac{1}{2}$	271
{ <i>E.</i>	249	5	7	844
{ <i>F.</i>	162	6	9	1092

A. *B.* and *C.* make a bank of 3256 *l.* whereof *A.* puts in 1026 *l.* *B.* 985 *l.* and *C.* the rest; by misfortune they lose 2000 *l.* what part of it must each bear?

	<i>l.</i>	<i>s.</i>	<i>d.</i>	Remainders.
<i>Answer,</i> { <i>A.</i>	630	4	5	928
{ <i>B.</i>	605	0	8 $\frac{1}{2}$	1240
{ <i>C.</i>	764	14	10	1088

FELLOWSHIP with TIME.

FELLOWSHIP with TIME is thus work'd; multiply each man's stock by the respective time he puts it in for, and add all the products, the total of which must be your first number through all the statings; the gain,

gain, or loss, the second (as before); and each man's particular stock, multiply'd by its time, the third.

Note, All the particular times (if not so given) must be reduced into one name, (*i. e.*) all years, all months, all weeks, or all days, &c.

The reason of multiplying the several stocks by the times they are put in for, will appear from the following considerations. *First*, suppose *A.* and *B.* put into trade each 100 *l.* for 1 month, then certainly their gain, whatever it be, must be equally divided betwixt them. Again, suppose *A.* puts in 100 *l.* and *B.* 200 *l.* both for the same time; 'tis as plain that *B.*'s share of the gain must be twice as much as *A.*'s, because his stock is double: or if each put in 100 *l.* but for different times, *viz.* *A.* for one month, and *B.* for 2; then as *B.*'s stock lies twice as long as *A.*'s, so his gain, as before, must be twice as great. *Lastly*, suppose *A.* to put in 100 *l.* for 1 month, and *B.* 200 *l.* for 2 months; then since his stock is not only double, but the time he leaves it in double too, his share of the profits must become 4 times greater than *A.*'s. And so in all other cases.

EXAMPLE.

A. put into company 560 *l.* for 8 months, *B.* 279 *l.* for 10 months, and *C.* 735 *l.* for 6 months; they gain'd 1000 *l.* What share of it must each have?

<i>l.</i>	<i>l.</i>	<i>l.</i>
560	279	735
8	10	6
4480	2790	4410
		2790
		4480
		11680

[90]

1/2. Then, $\frac{1}{2}$ 1168 | 0 — 1000 — 448 | 0
1000

$\frac{1}{2}$
1168) 448000 (383
3504

—
• 9760
9344

—
• 4160
3504

—
• 656
20

$\frac{1}{2}$
1168) 13120 (11
1168

—
• 1440
1168

—
• 272
12

$\frac{1}{2}$
1168) 3264 (3
2336

—
• 928
4

1168) 8712 (3
3504
—
• 208

[91]

$$\begin{array}{r}
 \begin{array}{c} L \\ 2d. \text{ If } 1168 | 0 \end{array} \begin{array}{c} L \\ 1000 \end{array} \begin{array}{c} L \\ 279 | 0 \end{array} \\
 \hline
 1000 \\
 \hline
 \begin{array}{c} L \\ 1168) 279000 (238 \\
 2336 \\
 \hline
 4540 \\
 3504 \\
 \hline
 10360 \\
 9344 \\
 \hline
 1016 \\
 20 \\
 \hline
 \end{array} \begin{array}{c} s. \\ 1168) 20320 (17 \\
 1168 \\
 \hline
 8640 \\
 8176 \\
 \hline
 464 \\
 12 \\
 \hline
 \end{array} \begin{array}{c} d. \\ 1168) 5568 (4 \\
 4672 \\
 \hline
 896 \\
 4 \\
 \hline
 1168) 3584 (3 \\
 3504 \\
 \hline
 80
 \end{array}
 \end{array}$$

3d. If $\frac{1168}{1000} \times \frac{1000}{441} = \frac{1168}{441}$

1168)441000(377

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>Rem.</i>	
<i>A's Share is</i>	383	11	2 $\frac{1}{2}$	208	3504
<i>B's Share is</i>	238	17	4 $\frac{1}{2}$	80	9060
<i>C's Share is</i>	377	11	4 $\frac{1}{2}$	880	8176

Value of the Remainders: $\frac{1}{4} \cdot 1168)1168($ $\cdot 8840$

1000 00 0— . . . 0 —————
The whole gain. • 664
30

1168)13280(11
1168

• 1600
1168

• 432
12

1168) 5184(4
4672

• 512
4

1168)2048(1
1168

880

More

More EXAMPLES.

A. B. and C. agreeing to trade together, A. puts in 529 l. for 4 months; B. 329 l. for 7 months; and C. 900 l. for 2 months; by their trade they gain 540 l. What part of it belongs to each?

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>Remainders.</i>
<i>Answer,</i> { <i>A.</i>	183	14	8	2304
{ <i>B.</i>	199	19	5	1332
{ <i>C.</i>	156	5	10 $\frac{1}{4}$	2583

Three persons make a joint-stock; *A.* puts in 400 pieces of holland, each containing 96 yards, at 5 s. 6 d. per ell *Flemish*, for 5 months; *B.* 600 guineas for 8 months; and *C.* 1800 l. for 4 months; but at 3 months end, takes out 800 l. they gain in all 1000 l. How much is each of their shares?

	<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>Remainders.</i>
<i>Answer,</i> { <i>A.</i>	860	4	3 $\frac{1}{2}$	3996
{ <i>B.</i>	61	11	8	1920
{ <i>C.</i>	78	4	0 $\frac{1}{4}$	2568



THE ART AND MYSTERY OF THE ART

CHAP. IX.

Of ALLIGATION.

ALLIGATION is the compounding many simples into one mass, according to any requir'd price, or proportion.

This rule is usually divided into two parts, distinguish'd by the names of *Medial* and *Alternate*.

ALLIGATION MEDIAL.

Alligation Medial answers such questions as having the quantities and prices of the several simples given, only demand the mean rate of any particular part of the composition.

RULE.

As the sum of all the simples,
To their total value:
So is any quantity of the mixture,
To the price thereof.

EXAMPLES.

(Ex. 1st.) A grocer wou'd mix 18 lb. of currans at 5 d. per lb. and 29 lb. at 6 d. per lb. with 12 lb. at 8 d. per lb. At what rate may he sell a pound of the mixture?

First,

[95]

First, Place the quantities and their values, as below.

lb.	d.	s.	d.
18	at 5	per lb.	comes to 7 6
29	at 6	_____	to 14 6
12	at 8	_____	to 8 0

Sum of all the Sim. 59

l. 1 10 0 tot. val.

Then, If 59 comes to 1 10 what will 1?

$$\begin{array}{r}
 20 \\
 \hline
 30 \\
 12 \\
 \hline
 59 \overline{) 360} \text{ (6 Answer.} \\
 \underline{354} \\
 6
 \end{array}$$

Ex. 2. A grocer would with 12 C. of sugar, at 3 l. per C. mix 3 C. at 50 s. per C. and 8 C. at 45 s. per C. What will 500 of this mixture be worth?

The quantities and their values, placed as before, will stand thus:

C.	l.	s.
12	at 3 l.	per C. is 36 00
3	at 50 s.	per C. is 7 10
8	at 45 s.	per C. is 18 00

Sum of the Simples 23

61 10 tot. val.

[96]

Then, $\overset{C.}{\text{If } 23} \text{ --- } \overset{L.}{61} \overset{s.}{10} \text{ --- } \overset{C.}{5}$

20

1230

5

23)6150(267

46

13 l. 7 s. 4 d. $\frac{1}{2}$ facit.

155

138

170

161

9

12

23)108(4

92

16

4

23)64(2

46

18

The proof of this is as in the *Rule of Three*, only by reversing the proportion.

So the first example may be prov'd by this back stating.

lb. d. lb.
If 1 --- 6 --- 59

And the last by this;

C. l. s. d. C.
If 5 --- 13 7 4 $\frac{1}{2}$ --- 23

remembering in both to take in the remainders.

More

More EXAMPLES.

If a vintner minglcth 13 gallons of canary, at 6s. 8d. per gallon, with 20 gallons of white wine, at 5s. per gallon, and 10 gallons of cyder, at 3s. per gallon, at what rate must he sell a quart of the mixture?

Answer, 1s. 3d.

If with 40 bushels of corn, at 4s. per bushel, there are mix'd 10 bushels at 6s. per bushel; 30 bushels at 5s. per bushel, and 20 bushels at 3s. per bushel, what will 10 bushels of the mistling be worth?

Answer, 2l. 3s.

ALLIGATION ALTERNATE.

Alligation Alternate teacheth what quantities of several simples (whose values are given) must be mixed, that the composition may bear a price propounded.

This sort of *Alligation* has three varieties.

VARIETY 1.

When the price of each simple is express'd, but no quantity given, and it is required how much of each simple must be mix'd, to sell any part of the composition at a mean price propounded.

In this variety you have only to link the several extremes rightly together, and to find the true differences betwixt them and the mean: for those differences are the quantities sought.

EXAMPLE.

A vintner would mix four sorts of wine, of 12d. of 18d. of 24d. and of 26d. per quart; what quantity of each must he take, to sell the mixture at 20d. per quart?

To

To place your numbers, and link the extremes, observe these rules.

RULES.

1st. Set down the several given prices (which must always be of one name) in a column, one under another; then, towards your left hand, draw a line of connection; and on the other side of the said line, place the mean rate.

Thus then will stand the given numbers of the given example.

$$20 \left\{ \begin{array}{l} 12 \\ 18 \\ 24 \\ 26 \end{array} \right.$$

2^d. Link them two and two together, always observing to join a greater and a less than the mean; and against each extreme place the difference betwixt the mean and its yoke-fellow:

Thus,

$$20 \left\{ \begin{array}{l} 12 \\ 18 \\ 24 \\ 26 \end{array} \right. \begin{array}{l} \boxed{} \\ \boxed{} \\ \boxed{} \\ \boxed{} \end{array} \begin{array}{l} 4 \\ 6 \\ 8 \\ 2 \end{array}$$

So the difference betwixt the extreme : 2, and 20 the mean, being 8, is placed against 24, its yoke-fellow; and between 18 and 20 being 2, is placed against 26: so also the difference betwixt 24 and 20 being 4, is placed against 12; and 6, the difference betwixt 26 and 20, is set against 18.

Therefore if he mixes 4 quarts at 12 *d.* 6 at 18 *d.* 8 at 24 *d.* and 2 at 26 *d.* per quart, he may sell the mixture at 20 *d.* per quart.

The proof of which is easy. For the sum of the differences valued at the mean rate, will be found equal to the amount of the particular differences at their given prices.

For

For 20 quarts, the sum of the differences at 20 d. per quart, is 400 pence; and 4, 6, 8, 2 quarts, the particular differences, at 12, 18, 24, 26 pence per quart, will come to the same sum.

But note, as many different ways as the extremes may be combin'd, so many different answers may be given to the question, yet all true.

So the same example being combin'd, thus:

$$20 \left\{ \begin{array}{|l} 12 \\ 18 \\ 24 \\ 26 \end{array} \right\} \begin{array}{|l} 6 \\ 4 \\ 2 \\ 8 \end{array} \} \text{Ans.} \quad 20 \left\{ \begin{array}{|l} 12 \\ 18 \\ 24 \\ 26 \end{array} \right\} \begin{array}{|l} 4.6 \\ 4.6 \\ 8.2 \\ 8.2 \end{array} \left| \begin{array}{l} 10 \\ 10 \\ 10 \\ 01 \end{array} \right\} \text{Ans.}$$

gives those different, but true answers, as may be proved by the same rule.

In the last of these examples the numbers being doubly combin'd, (i.e.) each with two others, make each have two differences set against it; for 12, the first extreme, being link'd both with 24 and 26, must have both their differences, viz. 4 and 6, placed against it; and so the rest. Which double difference must be added, and placed as above.

But when in a question there is but one extreme less, or but one greater than the mean; such a question will admit of but one answer, that single extreme being to be link'd with all the rest.

EXAMPLE.

A grocer would mix sugars, at 5 d. 6 d. and 10 d. per lb. so as to sell the compound at 8 d. per lb. What quantity of each must he take?

$$8 \left\{ \begin{array}{|l} 5 \\ 6 \\ 10 \end{array} \right\} \begin{array}{|l} 2 \\ 2 \\ 3.2 \end{array} \left| \begin{array}{l} 2 \\ 2 \\ 5 \end{array} \right\}$$

The numbers being plac'd, link'd, and differenced, (as above) according to the foregoing rules, it appears, to sell his sugar at 8 d. per lb. he must mix 2 lb. at 5 d. 2 lb. at 6 d. and 5 lb. at 10 d. per lb.

The

The reason of these combinations, and the alternate placing of their differences, will appear from this plain consideration, *viz.* That thereby whatever is lost upon the quantity sold, whose given price exceeds the mean, is gain'd again upon the quantity, whose given price is less than the mean.

More EXAMPLES.

A tobaccoist would mix tobacco of 2*s.* and 1*s.* 6*d.* and 1*s.* 3*d.* per lb. so as to sell the compound at 1*s.* 8*d.* per lb. What quantity of each must he take?

$$\text{Answer, } \begin{array}{l} \text{lb.} \quad \text{s.} \quad \text{d.} \\ \left\{ \begin{array}{l} 7 \text{ at } 2 \ 0 \\ 4 \text{ at } 1 \ 6 \\ 4 \text{ at } 1 \ 3 \end{array} \right\} \text{ per lb.} \end{array}$$

Several sorts of tea, *viz.* of 13*s.* 18*s.* 26*s.* and 30*s.* per lb. are to be so mixed, that the compound may be worth 22*s.* per lb. what quantity of each must there be?

$$\text{Answer, } \begin{array}{l} \text{lb.} \quad \text{s.} \\ \left\{ \begin{array}{l} 8 \text{ at } 13 \\ 4 \text{ at } 18 \\ 4 \text{ at } 26 \\ 9 \text{ at } 30 \end{array} \right\} \text{ per lb.} \end{array}$$

VARIETY 2.

Here we have the price of all the simples, and the quantity of one given, to find the several quantities of the rest: so that one measure, or quantity, may be sold at a mean rate propounded.

When the numbers have been set down, and their several differences found by the foregoing rules, you must proceed by this proportion.

As the difference of that number whose quantity is given,

To the rest of the differences one after another:

So the quantity given,

To the several quantities sought.

EXAMPLE.

EXAMPLE.

A distiller would with 40 gallons of French brandy, at 12 s. per gallon, mix English brandy at 7 s. per gallon, and spirits at 4 s. per gallon: how much of the last two sorts must be added, to sell the whole at 8 s. per gallon?

$$8 \left\{ \begin{array}{r|l} 12 & 1.4/5 \\ 7 & 4/4 \\ 4 & 4/4 \end{array} \right.$$

Now it is plain, that were there but 5 gallons of the French brandy, there must also be but 4 gallons of each of the other liquors; but since there are to be 40 gallons of the French brandy, say,

As 5, the difference against its price,

To 4, the difference against the price of the English brandy:

So is 40, the given quantity of the French,

To the quantity of English sought:

Which by this proportion will be found to be 32.

Then again,

As the first difference 5,

To 4, the difference against the price of the spirits:

So 40, the said given quantity,

To the quantity of spirits sought.

Which because their differences are alike, will be the same as of the English brandy, viz. 32.

This variety has the same proof as the former.

More EXAMPLES.

How much tea at 14 s. per lb. and of 18 s. per lb. must be mix'd with 8 lb. at 24 s. per lb. so as to allow the lb. at 20 s.?

$$\text{Answer, } \left\{ \begin{array}{l} 8 \text{ lb. at } 24 \text{ s.} \\ 4 \text{ lb. at } 18 \text{ s.} \\ 4 \text{ lb. at } 14 \text{ s.} \end{array} \right.$$

I would with 21 lb. of snuff, at 8 s. per lb. mix so much of 4 s. per lb. and so much of 5 s. per lb. that I might

might afford to sell the mixture at 6 s. per lb. What quantity of each must I take?

Answer, $\left\{ \begin{array}{l} 21 \text{ at } 8 \\ 14 \text{ at } 4 \\ 14 \text{ at } 5 \end{array} \right\}$ per lb.

VARIETY 3.

In this variety the particular prices of each simple being given, as also the mean rate of the compound, it is required how much of each sort must be taken, to make up the quantity propounded?

Which (after the work of the first variety) is performed by this proportion:

As the sum of the differences,
To the total quantity:
So each particular difference,
To its particular quantity.

EXAMPLE.

A druggist hath 4 sorts of green tea, at 5 s. 6 s. 8 s. and 9 s. per lb. and would make up a quantity of 87 lb. to sell at 7 s. per lb. how much of each must he take?

See the work.

lb.	s.	
7	$\left\{ \begin{array}{l} 5 \\ 6 \\ 8 \\ 9 \end{array} \right\}$	$\begin{array}{l} 2-29 \text{ at } 5 \text{ per lb.} \\ 1-14\frac{1}{2} \text{ at } 6 \text{ per lb.} \\ 1-14\frac{1}{2} \text{ at } 8 \text{ per lb.} \\ 2-29 \text{ at } 9 \text{ per lb.} \end{array}$
		6

lb.	lb.	lb.
If	6	87
		2
		6)174(29
		0
lb.	lb.	lb.
If	6	87
		1
		6)87(14½
		3

More

More EXAMPLES.

A vintner hath three sorts of wine, of 6 s. 8 s. and 10 s. per gallon, of all which he would compose a quantity of 120 gallons, to sell at 7 s. per gallon: what quantity must there be of each?

$$\text{Answer, } \left\{ \begin{array}{l} \text{gall.} \quad \text{s.} \\ 80 \text{ at } 06 \\ 20 \text{ at } 08 \\ 20 \text{ at } 10 \end{array} \right\} \text{ per Gall.}$$

A grocer having sugars of 5 d. 6 d. 8 d. 10 d. and 11 d. per lb. would make a mixture of 3 C. wt. to sell at 7 d. per pound: how much of each must he take?

$$\text{Answer, } \left\{ \begin{array}{l} \text{lb.} \quad \text{d.} \\ 28 \text{ at } 05 \\ 196 \text{ at } 06 \\ 56 \text{ at } 08 \\ 28 \text{ at } 10 \\ 28 \text{ at } 11 \end{array} \right\} \text{ per lb.}$$





C H A P. X.

Of POSITION, or the Rule of FALSE.

THIS rule has not the name of *False*, from its being in itself really erroneous, but only because that by the help of false supposed numbers we find the truth.

It is usually divided into two parts, *single* and *double*.

Single POSITION.

IN *Single POSITION* we make but one supposition, with which working as with a true number, we regulate the result by this proportion, *viz.*

As the total arising from the error,
To the true total:
So the suppos'd part,
To the true one.

E X A M P L E S.

1st. *A. B. and C. designing to buy a quantity of lead, to the value of 140 l. agree that B. shall pay as much again as A. and C. as much again as B. What then must each pay?*

Now,

Now, suppose *A.* to pay 10 *l.* then *B.* must pay 20 *l.* and *C.* 40 *l.* the total of which is 70 *l.* but should be 140 *l.* Therefore,

If 70 *l.* should be 140 *l.* what should 10 *l.* be?

l.

Answer, 20 for *A.*'s share;
which doubled, makes 40 for *B.*'s share;
and that again doubled, gives 80 for *C.*'s share.

The total of which is 140

2. Suppose the sum of 20 *l.* were to be paid by *A.* *B.* and *C.* thus, *A.* $\frac{1}{2}$, *B.* $\frac{1}{3}$, *C.* $\frac{1}{6}$; what must each pay according to that proportion?

	<i>l.</i>	<i>s.</i>	<i>d.</i>
First, the $\frac{1}{2}$ of 20 <i>l.</i> being	10	00	0
the $\frac{1}{3}$ —————	6	13	4
and the $\frac{1}{6}$ —————	5	00	0

The total will be 21 13 4

But it should have been but 20 *l.* therefore the parts found should be thus regulated:

<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>	<i>s.</i>	<i>d.</i>
If 21 13 4 fall to 20,			{ 10 00 0 }		
what will			{ 06 13 4 }		
			{ 05 00 0 }		
			Answer { 9 04 7 $\frac{1}{2}$ }		
			{ 6 03 0 $\frac{1}{2}$ }		
			{ 4 12 3 $\frac{1}{2}$ }		

which, with the addition of $\frac{1}{2}$, makes just 20 00 0—

found by dividing the total of $\left\{ \begin{array}{l} 28 \\ 36 \\ 40 \end{array} \right.$
the remainders ———

by the common divisor 52)104(2

0

More EXAMPLES.

A gentleman bought a chaise, horse, and harness for 50 *l.* the horse came to twice the price of the harness,

harness, and the chaise to twice as much as both horse and harness: what did he give for each?

	l.	s.	d.	Remainders.
<i>the harness</i>	of	11	1 $\frac{1}{2}$	15
<i>the horse</i>		11	02 $\frac{1}{2}$	30
<i>the chaise</i>		33	06 8	

A. B. and C. disputing of their age, A. affirms he is as old as B. and $\frac{1}{2}$ as old as C. and B. says, that he is $\frac{1}{2}$ as old as C. upon which C. says, he is sure both their ages, added to his, will make 110 years. I demand the age of each.

$$\text{Answer, } \begin{cases} A. 45 \frac{1}{2} \\ B. 27 \frac{1}{2} \\ C. 36 \frac{1}{2} \end{cases}$$

Double POSITION.

IN Double POSITION two suppositions are requir'd, which (if both prove false) are, with their errors, to be thus dispos'd.

Set down both your suppositions, and against each of them their respective errors, mark'd thus +, if too much; or thus—, if too little.

Then multiplying them cross-ways, that is, the first supposition by the second error, and the second supposition by the first error; if both the errors are alike, i. e. both too little, or both too much, subtract the lesser product from the greater, and divide the remainder by the difference of the errors. But if the errors are unlike, i. e. one too little, and the other too much, the sum of these products must be divided by the sum of the errors: the quotient will give the true number, exactly answering all the demands of the question.

Or the suppositions and their errors being plac'd as before, work by this proportion, as a general rule, viz.

As the difference of the errors, if alike,
Or their sum, if unlike,

To the difference of the suppositions:

So either error to a fourth number,

which accordingly added to, or subtracted from the
supposition against it, will answer the question.

EXAMPLES.

1st. *A. B. and C. playing at cards, the money stak'd
was 324 crowns; but disagreeing, each seiz'd as many
as he could; A. got a certain number, B. as many as
A. and 15 over; C. got a fifth part of both their sums
added together: how many had each?*

First, suppose *A. got 50*
then *B's share will be 65*
and *C's* ————— *23*

All which added, make but 138, which is 186 too few.

Then supposing again, that *A. got 80*
B's share will be 95
and *C's* ————— *35*

The total of which is still but 210, too few by 114.

Therefore, setting down the suppositions, and their
errors (mark d as before directed) against them, they
will stand thus:

Suppositions.	Errors.
50 —————	186
80 —————	114

then multiply'd cross-ways, the products will be
14380, and 5700; the lesser of which (the errors
being alike, i. e. both too little) being taken from
the greater, there will remain 9180 for a dividend;
which divided by 72, the difference of the two er-
rors, quotes 127 $\frac{1}{2}$, the true number of crowns *A.*
took up; & will appear, by adding 15 to them for
B's share, and dividing the sum of *A's* and *B's* by 5,
for

for C's share; for so their particular numbers will be found to be as follow:

$$\begin{array}{r} A's \text{ --- } 127 \frac{1}{2} \\ B's \text{ --- } 142 \frac{1}{2} \\ C's \text{ --- } 54 \\ \hline \end{array}$$

The total of which is 324, the number of crowns given.

Or by the other rule;

As 72, the difference of the errors, (because alike) to 30, the difference of the suppositions:

$$\text{So is } \left\{ \begin{array}{l} 186 \\ \text{or} \\ 114 \end{array} \right\} \text{ to } \left\{ \begin{array}{l} 77 \frac{1}{2} \\ \\ 47 \frac{1}{2} \end{array} \right\} \text{ which } \left\{ \begin{array}{l} 50 \\ \text{or} \\ 80 \end{array} \right\} \text{ gives } 127 \frac{1}{2} \text{ as before.}$$

EXAMPLE 2.

When first the marriage-knot was ty'd
Betwixt my wife and me;
My age did her's as far exceed,
As three times three does three.
But after ten and half ten years,
We man and wife had been;
Her age came up as near to mine,
As eight is to sixteen.

Now, pray,
What were our ages on the wedding-day?

$$\begin{array}{r} \text{First, suppose her 21 then he must be 63} \\ \text{then adding to each } 15 \text{ --- } 15 \\ \hline \text{her age becomes 36} \qquad \qquad \text{his 78} \end{array}$$

This error therefore is 3 years too few.
But supposing her 9, the error will prove 3 too many.

Setting down therefore against the suppositions the errors, with their respective marks, they will stand thus:

Sup

Suppositions. *Errors.*

21 — 3

9 + 3

Then multiplying cross-ways, 3 times 21 is 63
3 times 9 is 27

These products (because unlike) added, make 90 for a dividend, which divided by 6, the sum of the errors, quotes 15, her true age; prov'd thus:

She being 15, he must be—————45

15 years added to each 15

—————
Make her 30, just half of his————60

Or, by the other rule:

As 6, the sum of the errors, (because unlike) to 12, the difference of the suppositions:

So is the common error, 3 to 6; which either subtracted from 21, or added to 9, gives 15, (as before) for her age.

MORE EXAMPLES.

What number is that, to which if you add $\frac{1}{2}$ of itself, and from the sum subtract $\frac{1}{3}$ of itself, the remainder will be 210?

Answer, 219.

A gentleman caught a fish, whose head was 6 inches long, the tail as long as the head, and half as long as the body; the body was just the length of the head and tail. I demand the length of the fish?

Answer, 48 inches, or 4 foot.



CHAP. XI.

Of EXCHANGE.

EXCHANGE is the receiving money in one country, for the value paid in another.

NOTE.

The Par of exchange is certain and fix'd, being always *par pro pari, like for like*, according to the weight and fineness of the coin.

But the course or current running price between any two countries, rises and falls upon every occasion.

It would be both needless and endless to write of every kind of exchange; I shall therefore only give example of the exchanges of England, with some other chief countries of Europe. And first, with

FRANCE.

At Paris, Lyons, Rouen, &c. they keep their accounts in livres, sols, and deniers; and exchange upon the crown, the par of which in sterling-money is 47. 6d.

NOTE

NOTE

12 Deniers } make { 1 Sol.
20 Sols } { 1 Livre.
3 Livres } { 1 Crown.

French money is chang'd into Sterling by this proportion;

As a crown to the given rate:

So is the given French sum to the Sterling sought.

Or.

By supposing the given French crowns, guineas, and the rate of exchange, the price, so calling up their value by profits.

EXAMPLES.

18. What sterling money must be paid in London, to receive in Paris 438 crowns; exchange at 56 s. per crown?

Cr. d.
 1—56—438
 36
 2628 4 s. $\frac{1}{2}$
 2190 8 d. $\frac{1}{2}$
 12)24528(
 210)2044(
 3024 4 s.

Cr. d. s. d.
 438 at 56 or 4 s per Cr.
 87 12
 14 12
 108 4

Fi

2d. Charge

[112]

2d. Change 537 crowns, 14 sols, 10 deniers, into Sterling money; exchange at 52 d. $\frac{1}{2}$ per crown.

Cr. d.	Cr. Sols. De.	Cr. Sols. De. d.
If 1—52 $\frac{1}{2}$ —537 14 10	537 14 10 at 52 $\frac{1}{2}$	
60 2	60	
12—		45. $\frac{1}{2}$ 107 8
—105	32234	44. $\frac{1}{2}$ 8 19
720	12	$\frac{1}{2}$ $\frac{1}{2}$ 1 2 4 $\frac{1}{2}$
		Sols. 10 $\frac{1}{2}$ 8 $\frac{1}{2}$
	386818	2 $\frac{1}{2}$ 1 $\frac{1}{2}$
	105	2 $\frac{1}{2}$ 1 $\frac{1}{2}$
		Deniers. 10 $\frac{1}{2}$ of 10 Sols. $\frac{1}{2}$
	1934090	
	3868180	117 l. 10 s. 5 d. $\frac{1}{2}$ fac.
	2	

7210)106158910(56410

360

12)28205(5

461

210)23510

432

117 l. 10 s. 5 d. $\frac{1}{2}$ fac.

295

288

78

72

69

2

72)138(1

72

66

[113]

Sterling money is chang'd into *French* by this proportion:

As the rate of exchange, to one crown:
So is the given *English* sum, to the *French* sought.

For EXAMPLES.

Take the reverse of the former questions; which will also be their proof.

1st How many *French* crowns must be paid in *Paris*, to receive in *London* 102 l. 4 s. *Sterling*; exchange at 56 d. per crown?

d	Cr	l	s
56	—	102	4
		20	
		—	
		2044	
		12	
		—	
		56	Crown
		56	24528
		224	
		—	
		212	
		108	
		—	
		448	
		448	
		—	
		000	

1st

2^d Change

[114]

2d Change 117 l. 10 s. 5 d. $\frac{1}{2}$ Sterling into French crowns; exchange at 52 d. $\frac{1}{2}$ per crown.

d.	Crown.	l.	s.	d.
If 52 $\frac{1}{2}$	-----	117	10	5 $\frac{1}{2}$
0				30
210				2350
				12

18205
4

51	
60	
-----	Sols.
21 0 306 0 14	
21	

96	
24	

12	
12	

244	

21 0 11282 1 537	Crown.	Sols.	Deniers.
105		14	10

78			
62			

152			
147			

51			

66 the remainder of the other sum.

21)210(10 deniers.
21

00

More EXAMPLES.

If I pay in Paris 8297 crowns, 13 sols, 8 deniers, what may I draw my bill for to London, when the exchange is at 54 d. $\frac{1}{2}$ per crown?

Answer, 1875 l. 10 s. 4 d. $\frac{1}{2}$.

What Sterling money is equal to 954 crowns, 52 sols, when the exchange is at 58 d. $\frac{1}{2}$ per crown?

Answer, 231 l. 5 s. 1 d. $\frac{1}{2}$.

[115]:

If I pay in London 536 l. what French money shall I receive in Paris; exchange at 57 d. per crown?

Answer, 2256 crowns, 50 sols, 6 deniers.

What French money is equal to 1529 l. 10 s. exchange at 53 d. $\frac{1}{2}$ per crown?

Answer, 6893 crowns, 31 sols, 3 deniers.

Secondly, with ITALY.

IN Genoa, Leghorn, &c. they keep their accounts in livres, sols, and deniers; and exchange upon the piece of eight, or dollar; the par of which with London, is also 4 s. 6 d. Sterling.

NOTE.

At Genoa 5 livres make a piece of eight, at Leghorn 6. Observe the rules for exchanging with France.

EXAMPLES.

How much Sterling shall I receive in London, if I pay in Genoa 820 dollars; exchange at 51 d. per dollar, on piece of eight.

Dollar.	d.	Dollars.	Dollars.
If 1	51	820	820 at 51 d. per dollar.
		51	4
		820 d.	3280
		4100	3 $\frac{1}{2}$ 105
		12)41820	34815
		210)34815	174 l. 5 s.
		174 l. 5 s.	
		E 4	

Or,

Or, back again;

If in London I pay 174*l*. 5*s*. Sterling, how many dollars shall I receive in Genoa; exchange at 51*d*. per dollar?

d. *Dol.* *l* *s.*
If 51 ————— 1 ————— 174 5

20

3485

12

51)41820(810

408

• 102

102

...0

Value exchanges by the ducat; the *per* about 56*d*. $\frac{1}{2}$ Sterling.

NOTE

6 Shill } make { 1 Grosh.
24 Grosh } { 1 Ducat.

EXAMPLE

Change 512 ducats into Sterling money; exchange at 55*d*. $\frac{1}{2}$ *per* ducat.

D. *d.* *D.*
If 1 — 55 $\frac{1}{2}$ — 512 *

2 512

———— 512

111

2)56832(

12)28416(

: | 0.236 | 8

118 *l*. 8*s*.

Ducats. *d.*

512 at 55 $\frac{1}{2}$ *per* Duc.

4

d. 2048

6 $\frac{1}{2}$ 256

1 $\frac{1}{2}$ 64

236 | 8

118 *l*. 8*s*.

* See Abbreviations of Multiplication.

Thirdly, with SPAIN.

IN *Madrid, Seville, &c.* they keep their accounts in rials and mervadies, and exchange also by the piece of eight. The *par* with *London* 4*s.* 6*d.*

NOTE

34 Mervadies } make { 1 Rial.
8 Rials } 1 Piece of 8.

This exchange is also cast up by the foregoing rules.

EXAMPLE

What *Sterling* money may I draw for to *London*, if I pay in *Seville* 4798 rials, 25 mervadies; exchange at 50*d.* *Sterling* per piece of 8?

[118]

Rials. d. Rials. Mer.

If 8 — 58 — 4798 25

34 — 34

272

19197

14396

163157

98

1305256

815785

12

272) 2463106 (34790(2

816

21028919(

1308

1088

144 19 2 1/2

2157

3204

2470

2448

226

4

272) 2904 (3

816

88

Or,

[119]

Or, back again.

Change 144 l. 19 s. 2 d. $\frac{1}{2}$ Sterling into Spanish money
Exchange at 58 d. per piece of $\frac{1}{2}$.

$\frac{1}{2}$	Rials.	l.	s.	d.
144	19	2	$\frac{1}{2}$	
4				20

232	2899
	12

34799

4

139163

8

232)1113304(4798 Rials.

928

1853

1624

2290

2088

2034

1856

168

34

672

504

88 Rps. of the other.

232)5160(25 Maravedis.

464

1160

1160

000

More EXAMPLES.

Change 83927 Rials into pounds *Sterling*; exchange at 54 d. $\frac{1}{2}$ per piece of eight.

Answer, 2382 l. 6 s. 0 d. $\frac{1}{2}$.

If I pay in *London* 5000 l. what *Spanish* money may I draw my bill for to *Madrid*; exchange at 57 d. $\frac{1}{2}$ per piece of eight?

Answer, 168092 Rials, 17 *Mervadits*.

Fourthly, with PORTUGAL.

IN *Lisbon*, *Oporto*, &c. they keep their accounts in Rees, and exchange on the *Mill-ree*; the *par* of which is about 6 s. 8 d. $\frac{1}{2}$ *Sterling*.

NOTE.

1000 Rees make 1 *Mill-ree*.

To make this exchange, still observe the same rule.

EXAMPLES.

Change 48009 rees into *Sterling* money; exchange at 6 s. 5 d. per *mill-ree*.

M R.	s. d.	Rees.
If 1—	6 5—	48009
1000	12	77
	—	—
	77	336063
		330063
		—
		12
		1'030)36961693(3696(
		4—
		—210)3018
		21772—
		15 l. 8 s. 0 d. $\frac{1}{2}$.

Or,

Or, back again;

Change 15 l. 8 s. 0 d. $\frac{1}{2}$ Sterling into rees; exchange at 6 s. 5 d. per mill-rec.

	Rees.	l.	s.	d.
If 6 s. 5 d.	1000	15	8	0 $\frac{1}{2}$
12			20	
77			308	
4			12	
308			3696	
			4	
			14786	

Note, 772, Rem. of 308) 14786772 (48009
the other stating, is 1232
here taken in.

2466
2464
2772
2772
0000

More EXAMPLES.

What Sterling money is equal to 595677 rees; exchange at 6 s. 7 d. per mill-rec?

Answer, 196 l. 1 s. 6 d. $\frac{1}{2}$.

Change 59 l. 12 s. into rees; exchange at 6 s. 10 d. $\frac{1}{2}$ per mill-rec.

Answer, 173381 rees.

Exactly.

Fifthly, HOLLAND, FLANDERS, and GERMANY.

I Take these places together, because their accounts are kept, and their exchange with *England* made the same way.

For not only in *Amsterdam*, but also in *Amberg*, and *Hamburg*, they keep their accounts in pounds, shillings, and pence *Flemish*; or guilders, stivers, and pennicks; and exchange with us upon our pound, giving us for it, when at *par*, 33 s. 4 d. *Flemish*.

NOTE.

Their pounds, shillings, and pence, are divided as ours; viz. their pound into 20 shillings, and their shilling into 12 pence.

Their other money is thus divided.

16 Pennicks } make { 1 Stiver.
20 Stivers } make { 1 Guilder.

Note also,

6 Stivers } make { 1 Shilling } *Flemish*.
6 Guilders } make { 1 Pound }

Sterling money is changed into *Flemish* by this proportion; viz.

As 1 *Sterling* to the given rate:

So is the given *Sterling* to the *Flemish* sought.

Or,

By supposing the given *Sterling*, *mark*, and the given rate, their price, calling up their value by *proportion*.

EXAMPLE

EXAMPLE.

If I pay in *London* 492 *l.* Sterling, what may I draw my bill for to *Amsterdam*; exchange at 34 *s.* 5 *d.* *Flamish* per pound Sterling?

<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>l.</i>
If 1	34	5	492
	12		413
Or by Practice.	413		1476
<i>l.</i>	<i>s.</i>	<i>d.</i>	492
492 at 34 <i>s.</i> 5 <i>per l.</i>			1968
<i>s.</i> 10 $\frac{1}{2}$	246		
4 $\frac{1}{2}$	98	8	
<i>d.</i> 4 $\frac{1}{2}$	8	4	
1 $\frac{1}{2}$	2	1	
846 <i>l.</i>	13 <i>s.</i>	facit	
			846 <i>l.</i> 13 <i>s.</i> <i>Fl.</i>

If you would have the answer in guilders and stivers,
Divide the *Flamish* pence by 40, (the number of pence which make a guilder) and the quotient will be guilders; and if any thing remains, the half of it will be stivers, two *Flamish* pence being one stiver.

Or,

Multiply the *Flamish* pounds and shillings by 6, and it will produce guilders and stivers; for 6 guilders make 1 pound *Flamish*, and 6 stivers 1 shilling *Flamish*; and if there be any odd pence, multiply them by 8, for *Pro-nick*.

EXAMPLE.

846 <i>l.</i> 13 <i>s.</i> the sum of the last sum.	
6	<i>Flamish</i> pence.
	410 203 19 6 (36 Rem.
5079 <i>G.</i> 18 <i>s.</i>	
	5079 Guild. 18 Stivers.
	<i>Flamish</i>

Flemish money (whether pounds, shillings, &c. or guilders, stivers, and pennicks) is exchanged into Sterling thus:

As the given rate to 1 pound Sterling;
So is the given *Flemish* to the Sterling sought.

E X A M P L E S.

Change 846 *l.* 13 *s.* *Flemish* into Sterling money;
exchange at 34 *s.* 5 *d.* *Flemish* per *l.* Sterling.

<i>s.</i>	<i>d.</i> <i>Flem.</i>	<i>l.</i> <i>Storl.</i>	<i>l.</i>	<i>s.</i> <i>Flem.</i>
If 34	5	1	846	13
	12			20
413			16933	13

413) 103196 (492 *l.* Sterling.
1652

3799

3717

826

826

0

Or,

Change 5079 guilders, 18 stivers, into Sterling money;
exchange 34 *s.* 5 *d.* per *l.* Sterling.

s. d. Flem. l. Sterl.	Guild. Strv.
4 34 5	5079 18.
12	20
413	101598
	2
	413)203196(492 l. Sterl.
	1652
	3799
	3717
	826
	826
	0.

More EXAMPLES.

Change 475 l. Sterling into Flemish money; exchange at 33 s. Flemish per l. Sterling.

Answer, 783 l. 15 s. Flemish.

What Flemish money is equal to 365 l. 12 s. exchange at 36 s. 5 d. per l. Sterling?

Answer, 665 l. 13 s. 11 d. Flemish.

If I pay at Amsterdam 5389 l. 14 s. Flemish, what Sterling money shall I receive at London; exchange at 32 s. 8 d. Flemish per l. Sterling?

Answer, 3299 l. 16 s. 3 d. ½.

Change 572 l. 12 s. Sterling into guilders, stivers, &c. exchange at 34 s. 10 d. Flemish per l. Sterling.

Answer, 5984 guilders, 3 stivers, 13 pennicks.

What may I draw my bill for to London, if I pay in Amsterdam 7256 guilders; exchange at 35 s. 2 d. ½ per l. Sterling?

Answer, 686 l. 19 s. 2 d. Sterling.

*An Explanation of some Characters, sometimes
used for Brevity's sake.*

$+$ IS the mark of *Addition*, and shews the numbers it is placed between, are to be added together.

$-$ Is the mark of *Subtraction*, and shews the latter of the numbers it stands between, is to be taken from the former.

$\times$ Is the mark of *Multiplication*, and shews the numbers on each side are to be multiply'd together.

$\div$ Is the mark of *Division*, and plac'd between two numbers, shews the first is to be divided by the last.

$=$ Is the mark of *Equality*, and shews the number or numbers preceding it, are equal to that which follows it.

$\sqrt{}$ placed before any figures shews the *Square Root* of them is meant. And

$\sqrt[3]{}$ before a number, denotes its *Cube-Root*.

$::$ Is the sign of *Proportion*, and being plac'd between the two middle terms of 4 proportions, signifies *fit*.

To make all more plain, observe,

Thus the Characters are us'd :

$$2 : 4 :: 6 : 12 \quad \sqrt[3]{4096} = 16, \quad \sqrt{16} = 4, \quad 4 + 2 = 6, \\ 6 - 2 = 4, \quad 4 \times 2 = 8, \quad 8 \div 2 = 4.$$

And thus read:

As 2 is to 4, so is 6 to 12; the Cube-Root of 4096 is, or is equal to 16; the Square-Root of 16, is equal to 4; 4 added to, or more by 2, is equal to 6; and 6, made less by 2, is equal to 4; again, 4, multiply'd by 2, is equal to 8; and 8, divided by 2, is equal to 4.

ARITHMETIC

CHAP. XII.

Of Arithmetical and Geometrical Proportion or Progression.

PROGRESSION being a rule more curious than useful, and requiring more words for its full explication, than are consistent with this Compendium, I shall only give some (the most necessary) propositions in both its parts, arithmetical and geometrical; and refer the more inquisitive reader to Mr. Cajori's *Class Mathematics*, for his further satisfaction.

In all continued progressions, or distributions of numbers, that number which is compared to another is called the *Antecedent*; and the number to which it is compared is called the *Consequent*.

There are two ways of comparing numbers with one another: 1st. With respect only to their simple difference, i.e. how much the one, viz. the antecedent, is greater, or less than the other, viz. the consequent, found by subtraction: thus the difference betwixt 9 and 8, is 1; which difference is called the *Arithmetical Ratio*. 2^d. Numbers are compared with one another, when we consider how often one number contains, or is contained in another; and this is found by division, the quotient being the *geometrical ratio*. Thus, 3 is the *geometrical ratio* betwixt 3 and 16.

ARITHMETICAL PROGRESSION.

ARITHMETICAL PROGRESSION is the regular increase or decrease of any rank of numbers by the continual addition or subtraction of some equal number.

So 1, 4, 7, 10, 13, 16, are in *Arithmetical Progression* to each other, equally increasing by the continual addition of 3.

And so also are 84, 82, 80, 78, regularly decreasing by the continual subtraction of 2.

Some of the most considerable properties of numbers in *Arithmetical Progression* are as follow:

1. That in any rank of numbers in *Arithmetical Progression* consisting of three, or any odd number of terms, the double of the middle term will be equal to the sum of the two extremes, or of any two means, equally distant from the said middle term.

1, 2, 3, 4, (5), 6, 7, 8, 9.

Thus in the rank above 5, the middle term doubled is 10, = 1 + 9, the two extremes, or 2 + 8, or 3 + 7, or 4 + 6, the several correspondent means.

2. That in any rank of numbers in *Arithmetical Progression* consisting of four, or any even number of terms, the sum of the two extremes will be equal to the sum of the two middle numbers, or of any two means equally distant from the said extremes.

2, 4, 6, 8, 10, 12, 14, 16.

Thus in the rank above 2 + 16, the two extremes make 18, = 4 + 14, the two middle numbers, or 6 + 12, or 8 + 10, the other correspondent means.

In PROGRESSION, five Things are to be noted.

VIZ.

- I. The first Term.
- II. The last Term.
- III. The number of Terms.
- IV. The equal Difference.
- V. The sum of all the Terms.

Any three of which being given, the other two may be found; as Mr. Oughtred in his *Clavis Mathematica*, Chap. 19. Prop. the 6th, exemplifies in 20 propositions; some of the most useful of which are as follow.

PROPOSITION I.

The last term, number of terms, and equal difference being given, to find the first term:

Or, the second, third, and fourth given, to find the first.

RULE.

Multiply the fourth by the third, made less by one, and subtract the product from the second, the remainder is the answer.

EXAMPLE.

A man takes out of his pocket, at 6 several times, 6 several numbers of shillings, every one exceeding the former by 6; the last was 42, what was the first?
Answer, 12 s.

$$6 \times 5 = 30, 42 - 30 = 12 \text{ Answer.}$$

PRO-

PROPOSITION II.

The first, third, and fourth given, to find the second.

RULE.

From the product of the fourth, multiply'd by the third, subtract the fourth; the remainder added to the first, gives the second.

EXAMPLE.

What's the last number of an *Arithmetical Progression*, beginning at 4, and continuing, by the increase of 12, to 18 places? *Answer*, 208.

$$12 \times 18 = 216, 216 - 12 = 204, 204 + 4 = 208 \text{ Answer.}$$

PROPOSITION III.

The first, second, and fourth given, to find the third.

RULE.

Subtract the first from the second, and divide the remainder by the fourth; the quotient, with one added, gives the third.

EXAMPLE.

A traveller went 12 miles the first day, and increas'd every day's journey by 4 miles, till at last he went 64 miles in one day: How many days did he travel? *Answer*, 14 days.

$$64 - 12 = 52, 52 \div 4 = 13, 13 + 1 = 14 \text{ Answer.}$$

PROPOSITION IV.

The first, second, and third given, to find the fourth.

RULE.

R U L E.

Subtract the first from the second, and divide the remainder by the third, made less by one, the quotient gives the fourth.

E X A M P L E.

The ages of seven children increase by *arithmetical Progression*; the youngest is 2 years old, the eldest 32: what's the common difference of their ages? *Answer*, 5 years.

$$32 - 2 = 30, 30 \div 7 - 1 = 5 \text{ Answer.}$$

P R O P O S I T I O N V.

The first, second, and third given, to find the fifth.

R U L E.

Half the sum of the first and second, multiply'd by the third, produces the fifth.

E X A M P L E.

12 persons give their charity to a poor man in *arithmetical Progression*; the first gave 2 pence, the last 2 shillings, or 24 pence: how much did the poor man get? *Answer*, 156 pence, or 13 shillings.

$$2 + 24 = 26, 26 \div 2 = 13, 13 \times 12 = 156 \text{ Answer.}$$

G E O M E T R I C A L P R O G R E S S I O N.

GEOMETRICAL PROGRESSION is the increasing or decreasing of any rank of numbers by some equal ratio, that is, by the continual multiplication or division of some equal number.

Thus,

Thus, 1, 4, 8, 16, 32, increase in Geometrical Progression by a double Ratio, or continual multiplication by 2; and 405, 135, 45, 15, 5, decrease after the same manner by a continual division by 3, or by a triple Ratio.

Some of the most considerable properties of numbers in Geometrical Proportion are as follow:

1. That in any rank of numbers in Geometrical Progression, consisting of three, or any odd number of terms, the product of the middle term multiply'd by itself, will be equal to the product of the two extremes, or of any two means equally distant from the said middle term.

1, 2, 4, (8), 16, 32, 64.

Thus in the rank above, 8, the middle term squar'd, i. e. multiply'd by itself, is $64 = 1 \times 64$, the two extremes, or 2×32 , or 4×16 , the correspondent means.

2. That in any rank of numbers in Geometrical Progression, consisting of four, or any even number of terms, the product of the two extremes will be equal to the product of the two middle numbers, or of any two means equally distant from the said extremes.

1, 2, 4, 8, 16, 32, 64.

Thus in the rank above $1 \times 64 = 8 \times 8$, the two extremes produce $1 \times 8 = 2 \times 4$, the two middle numbers, or to 4×2 , the other correspondent means.

In Geometrical Progression the same five things are to be noted as in Arithmetical Progression:

V I Z.

- I. The first Term.
- II. The last Term.
- III. The number of Terms.
- IV. The Ratio, or equal difference.
- V. The sum of all the Terms.

Note, Figures are sometimes set over a rank of geometrical proportionals, as here-under, and are called Indices or Exponents; serving to shew the distance of any term from unity, or from the first term of the series.

Thus $\begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ 1 & 2 & 4 & 8 & 16 & 32 & 64 \end{matrix}$

PROPOSITION I.

To find any remote term of a *Geometrical Progression*, proceeding from unity, whose *ratio* or common difference is known, without producing all the intermediate terms.

RULE.

Find some few of the leading terms, and place over them their Exponents; then multiplying the last-found term by itself, it will produce a term double thereto; which again multiply'd by itself, will produce another double to the last: Thus proceed, till either you produce the term sought, or one a little short of it; which may be completed by multiplying it again by that term, which stands under such exponent as would make up the number.

Or, in other words, observe what figures of the exponents found added together, would give the exponent of the term wanted, and the numbers standing under the said exponents, multiply'd into each other, will produce the term requir'd.

From whence may be observed the coherence or agreement betwixt numbers in arithmetical and geometrical proportion.

EXAMPLE.

One agrees for 14 oranges, to pay only the price of the last, at a farthing for the first, an half-penny the second, &c. still doubling the price for the next, what must he give?

G

Here,

Here, setting down only the five first terms, with their exponents, the fourteenth may thus be found, $5+5+4=14$. So the terms under those exponents being multiply'd into each other, give the term answering. But as the exponent 1 stands always over the second term, so the exponent 13 answers to the 14th term; therefore add only 3 to the two 5's; and so always that exponent must be taken, which is one short of the term requir'd; as for 20, 19; for 30, 29, &c. which must be carefully noted.

See the work of the foregoing example.

$$\begin{array}{cccccc} 0 & . & 1 & . & 2 & . & 3 & . & 4 & . & 5 \\ 1 & . & 2 & . & 4 & . & 8 & . & 16 & . & 32 \end{array}$$

Exponents.

Terms.

$$\begin{array}{r} 5 \\ 5 \\ 3 \\ \hline 13 \end{array}$$

32 the 5th multiply'd by
32 itself.

$$\begin{array}{r} 64 \\ 96 \\ \hline \end{array}$$

gives 1024 the 10th, which
multiply'd by —8 the 3d Term,

gives 8192 the 14th.

And so many farthings, or 8 l. 10 s. 8 d. must be give at the rate agreed.

PROPOSITION II.

To find any remote term of a Geometrical Progression, not proceeding from unity, whose ratio and first term is given, without producing all the intermediate terms.

RULE

R U L E.

Set down, as before, some few of the leading terms with their exponents, and multiply also (as in the first proposition) the terms under such exponents, as added, would make the exponent short by one of the terms requir'd; only remember, that every product must here be divided by the first term.

E X A M P L E.

A sum of money is thus to be divided among 9 Persons, the 1st to have 50 l. the 2d 150 l. and so on in that proportion, one three times more than the other, to the last; what will the last have?

Setting down the five first terms with their exponents, thus,

$$\begin{array}{cccccc} 0 & 1 & 2 & 3 & 4 \\ 50 & 150 & 450 & 1350 & 4050 \end{array}$$

Multiply the last term by itself, and divide the product by 50, the first term, the quotient will be 328050 the 9th term required, answering to the 8th exponent.

Or setting down but the three first terms, multiply the last by itself, and divide the product by the 1st term, it quotes the 5th; which again multiply'd by itself, and divided by the first, will quote the 9th, as before. See the work.

$$\begin{array}{r} \begin{array}{ccc} 0 & 1 & 2 \\ 50 & 150 & 450 \end{array} & \begin{array}{r} 450 \\ 450 \\ \hline 22500 \\ 1800 \\ \hline \end{array} & \begin{array}{r} 4050 \\ 4050 \\ \hline 202500 \\ 162000 \\ \hline \end{array} \\ & 5|0)20250|0(& 5|0)1640250|0(\end{array}$$

4050 328050
Answer, 328050 l. for the 9th person.

PROPOSITION III.

Having the first term, the common excess, and the number of places given, to find the total sum of the whole progression.

RULE.

Having found the last term by the foregoing rules, subtract from it the first, and divide the remainder by the common excess, made less by one; the quotient is the sum of all, except the last; to which that being also added, gives the total requir'd.

Notes, If the *ratio* be double, that is, if the common excess be 2, the difference between the least and the greatest term, added to the greatest, gives the total sum.

If the *ratio* be triple, $\frac{1}{2}$ the difference must be added; if quadruple, $\frac{1}{3}$, &c.

EXAMPLES.

1st. A coffee-man, upon the signing of the last peace, for 50 guineas down, agreed to pay the first day one coffee-berry, the second two, the third four, and so on, to double the quantity every day, till the same was proclaim'd. What number of berries would it amount to, supposing the time 60 days; and what would their value be, supposing 1000 berries to the pound, and the pound to be sold at 5 s.?

See the work.

[137]

<i>Days.</i>	<i>Berries.</i>
1— 1	16
2— 2	16
3— 4	96
4— 8	16
5— 16	256

2
512 the 10th day.

16
3072
512
8192
2

16384 the 15th day.

16384
65536
131072
49152
98304
16384
268435456
2

536870912 the 30th day.
536870912

1073741824
536870912
4831838208
37580963840
4294967296
3221225472
1610612736
2684354560
288230376151711744
2

576460752303423488 the 60th day.

1000(1152921504606846)975 Tot. number of berries.
5 s. $\frac{1}{2}$ 288230376151711 l. 10 s. their val. at 5 s. per lb.

G 3

Ex. 2.

Ex. 2. A Grazier offers 40 oxen for a farthing a head, and treble it throughout; to what sum will it amount?

See the Work.

Oxen. Farthings.

1— 1	1162261467
2— 3	1162261467
3— 9	
4— 27	8135830269
5— 81	6973568802
81	4649045868
	1162261467
81	6973568802
648	2324522934
	2324522934
6561	6973568802
3	1162261467
	1162261467
19683 10th Ox.	
19683	1350851717672992089
	3
59049	
157464	4052555153018976267 40th Ox.
118098	
177147	6078832729528464400 100 Ox.
19683	Or,
	63321174265921501. 8 s. 4 d.
387420489	
3	
1162261467 the 20th Ox.	



C H A P. VIII.

Of VULGAR FRACTIONS.

A FRACTION is a part or parts of an unit, and written with two figures, with a line drawn between them, as $\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{8}$.

The figure under the line is called the *denominator*, because it gives name to the fraction, and also shews into what parts the unit is broken; and that above, the *numerator*, because it tells how many of such parts are meant by the fraction. Thus the fraction $\frac{3}{4}$ shews that the unit is divided into 4 parts, and that 3 of those parts are thereby express'd.

1. *Note*, therefore, That if the *numerator* and *denominator* of a fraction should be equal, as $\frac{2}{2}$, $\frac{5}{5}$, the value of such fraction would be exactly an unit or integer; for, by the definition above, the *denominator* shews into how many parts the unit is broke; and the *numerator* expresses how many of those parts are meant by the fraction. Then in the fraction $\frac{4}{4}$, the *denominator* declaring the unit to be broke into 4 parts, and the *numerator* expressing 4, that is, all of those parts, it is plain the said fraction is equal to an unit or whole number; because the sum of all the parts must be equal to the whole. From which observation it is also plain, that so often as the *denominator* is contained in the *numerator*, so many whole numbers or units are contain'd in such improper fraction. And this *Note* may serve as a

reason for the operations of the 1st, 2d and 3d sorts of Reduction.

2. Note also, That as all fractions do indeed arise from the remainders of divisions, when the divisor can no longer measure the dividend, so every fraction may be looked upon as the two given terms of a division, the *numerator* as the dividend, and the *denominator* as the divisor; from whence it appears, that if the *numerator* and *denominator* of a fraction be either multiply'd or divided both by the same number, the products or quotients will still remain in the same proportion, and the new fraction so arising, be of the same value with that given. Thus the fraction $\frac{3}{4}$, multiply'd by 2, will produce $\frac{6}{8}$; or divided by 2, will quote $\frac{1}{2}$; all which fractions are of the same value; 4 bearing the same proportion to 8, and 1 to 2, as 2 does to 4. And from hence also may appear the reason of the 1st, 5th, and 6th sorts of Reduction.

Of Vulgar Fractions there are four sorts, viz.

- 1st. A *proper*; whose *numerator* is always less than its *denominator*, as $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, &c.
- 2d. An *improper*; whose *numerator* is always equal to, or greater than its *denominator*, as $\frac{3}{2}$, $\frac{4}{3}$, &c.
- 3d. A *compound*, or *fraction of a fraction*; known by the word *of*, as $\frac{2}{3}$ of $\frac{1}{2}$, &c.
- 4th. A *mix'd fraction*; which is a fraction join'd with a whole number, as $5\frac{1}{2}$, $3\frac{2}{3}$, &c.

Before fractions can be either added or subtracted, they must be reduced into one denomination; and therefore, before we proceed to those rules, we must learn Reduction.

REDUCTION of FRACTIONS.

IN *Reduction of Fractions* there are seven varieties.

First, To reduce a whole number into an *improper fraction*, which is done by placing 1 for its *denominator*.

EXAMPLES.

Reduce 4 to a Fraction, *facit* $\frac{4}{1}$.
or 18, ————— *facit* $\frac{18}{1}$.

But if you would assign it any other *denominator*, multiply the whole number by the *denominator* assign'd, and place the product for a *numerator* over the assign'd *denominator*.

EXAMPLES.

Reduce 12 to a fraction, whose *denominator* let be 8.
 $\frac{12}{8}$ *facit* $\frac{24}{8}$.

Or if 6 were to be made a fraction, and its *denominator* to be 7, it would become $\frac{42}{7}$.

For the reason of this rule consider the two foregoing notes.

Second, To reduce a mix'd fraction into an improper one.

Multiply the whole number by the *denominator* of the fraction given, and take in the *numerator*; the product place for a new *numerator* over the *denominator* given.

E X A M P L E S.

Reduce $5\frac{1}{3}$ to an improper fraction, *facit* $\frac{16}{3}$.

$$\begin{array}{r} 3 \\ \hline 16 \\ \hline 3 \end{array}$$

So $12\frac{1}{2}$ reduc'd to an improper fraction, will be $\frac{25}{2}$.

The reason of this rule is the same as the foregoing, there being no difference in the operation, but the taking in the given *numerator*.

Third, To reduce an improper fraction into its equivalent whole or mix'd number.

R U L E.

Divide the *numerator* by the *denominator*, the quotient gives the whole number contain'd: But if any thing remains, (as in the 2d example) it must be placed as a new *numerator* over the given *denominator*.

E X A M P L E S.

Reduce $\frac{12}{8}$ to its equivalent whole number:
 $8)12(4$ *facit*.

$$\begin{array}{r} 0 \\ 6)45(7\frac{1}{6} \text{ facit.} \\ \underline{42} \\ 3 \end{array}$$

This being only the reverse of the foregoing rule, the same reason still holds.

Fourth,

Fourth, To reduce a compound fraction to a single one, i. e. a fraction of a fraction, to a fraction of an unit.

R U L E.

Multiply all the *numerators* together for a *numerator*, and all the *denominators* for a *denominator*.

E X A M P L E S.

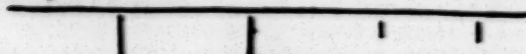
Reduce $\frac{2}{3}$ of $\frac{1}{4}$ to a single fraction, *facit* $\frac{1}{6}$.

Reduce $\frac{2}{3}$ of $\frac{5}{8}$ of $\frac{3}{4}$ to a single fraction.

$\frac{4}{6}$	$\frac{5}{8}$	$\frac{144}{360}$ <i>facit.</i>
24	40	
7	9	
168	360	

So also $\frac{1}{3}$ of $\frac{2}{3}$ is $\frac{2}{9}$.

The reason of this operation will best appear by representing the unit or whole number by a line, which, according to the first example, must be supposed to be divided into 4 parts, and each of those parts again into 3 smaller parts; thus,



Then, as $\frac{1}{4}$ of the unit will denote 1 of the larger divisions, so $\frac{2}{3}$ of that fourth must signify only 2 of the lesser divisions; consequently, if I would express what part of the whole line $\frac{2}{3}$ of $\frac{1}{4}$ is, it will plainly appear to be $\frac{1}{6}$: or, had the compound fraction been $\frac{2}{3}$ of $\frac{1}{4}$, the single fraction equal to it had been $\frac{1}{6}$. &c.

Fifth, To reduce a fraction into its lowest terms.

R U L E.

Divide the *numerator* and *denominator* by any figure, so that nothing may remain, and the quotients will be a new fraction of the same value with that given.

The rule generally given for finding the greatest common measure, or number, to divide your given fraction by, is this.

Divide the *denominator* by the *numerator*, and the *numerator* by the *remainder*, if any. So continuing to make the last divisor the dividend, and the remainder the divisor, till nothing remains, the last divisor will be the greatest common measure, or number, by which you can divide your fraction.

EXAMPLE.

What is the greatest common measure by which $\frac{224}{624}$ can be divided?

$$\begin{array}{r}
 208 \overline{)684} (3 \\
 \underline{624} \\
 60 \overline{)208} (3 \\
 \underline{180} \\
 28 \overline{)60} (2 \\
 \underline{56} \\
 \text{Answer, } 4 \overline{)28} (7 \\
 \underline{28} \\
 0
 \end{array}$$

$\frac{224}{624}$ then being divided by 4, gives $1\frac{1}{3}$, which are its lowest terms.

But this way of finding the common measure is too tedious, often making more work than it saves. Observe therefore these more practical directions.

If you cannot at once discover the greatest number you may divide by, if both your *numerator* and *denominator* are even numbers, you may always halve them, and often that way reduce your fraction to advantage.

Thus

Thus the fraction given in the foregoing example, divided twice by 2, gives, as before, $\frac{3}{7}$.

$$2 \frac{3}{7} \div 2 = \frac{3}{14}$$

add $\frac{3}{14}$ may be reduced, by continual halving, to $\frac{3}{28}$.

$$2 \frac{3}{28} \div 2 = \frac{3}{56}$$

Also, when both your *numerator* and *denominator* have cyphers on the right hand, you may abbreviate the fraction, by striking off an equal number from both.

$$\text{Thus } \frac{30}{60} \text{, or } \frac{300}{600}$$

Or, if the right hand figures of your *numerator* and *denominator* are both fives, or one a five, and the other a cypher, (as the remainder of the last example) you may always divide them by 5.

$$\text{Thus } \frac{35}{75} \text{ divided by } 5, \\ \text{is } \frac{7}{15}, \text{ equal to } \frac{35}{75}.$$

$$\text{So also is } \frac{45}{95} \text{ reduced to } \frac{9}{19}.$$

Thus, in the Rule of Three, we abbreviate our statements by the same rule, and on the same reason; for the second and third numbers multiply'd together, are as a *numerator* to the first number, their *denominator*.

For the reason of this rule, see the 2d note.

Sixth, To reduce fractions of divers denominations into one of the same value.

R U L E.

Multiply each of the given *numerators* into all the given *denominators*, except its own; and the several products

products will be so many new *numerators*, whose common *denominator* must be the product of all the given *denominators* multiply'd together.

EXAMPLES.

Reduce $\frac{3}{8}$, $\frac{5}{4}$, and $\frac{6}{10}$ into one denomination.

To do which,

First. The *numerator* 3 must be multiply'd by the *denominators* 8 and 10, which will produce 240
Secondly, the *numerator* 5, multiply'd by the *denominators* 4 and 10, will produce 200
Thirdly, The *numerator* 6, multiply'd by the *denominators* 4 and 8, will produce 192

} *New numerators.*

Then the three *denominators* 4, 8, 10, multiply'd together, will give 320 for a common *denominator*.

See the work.

$\frac{3}{8}$	$\frac{5}{4}$	$\frac{6}{4}$	$\frac{4}{8}$
24	20	24	32
10	10	8	10
240	200	192	320

1st Numer. 2d Numer. 3d Numer. Denominator.

$\frac{240}{320}$ $\frac{200}{320}$ $\frac{192}{320}$

So $\frac{3}{8}$, $\frac{5}{4}$, and $\frac{6}{10}$, reduc'd into one denomination, will be $\frac{240}{320}$, $\frac{200}{320}$, $\frac{192}{320}$.

See

See the work.

$\frac{5}{8}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{9}{10}$
$\frac{40}{12}$	$\frac{30}{12}$	$\frac{40}{8}$	$\frac{90}{8}$
$\frac{480}{15}$	$\frac{360}{15}$	$\frac{320}{15}$	$\frac{720}{12}$
$\frac{2400}{480}$	$\frac{1800}{360}$	$\frac{1600}{320}$	$\frac{8640}{8640}$
7200	5400	4800	
1st Numer.	2d Numer.	3d Numer.	4th Num.

$$\begin{array}{r}
 10 \\
 8 \\
 \hline
 80 \\
 12 \\
 \hline
 960 \\
 15 \\
 \hline
 4800 \\
 960 \\
 \hline
 14400 \\
 \text{Denominator.}
 \end{array}$$

The foregoing is the common rule for reducing fractions of several denominations into one: it may also be done by first finding the common denominator as before directed, and then to produce the new numerators dividing the said common denominator severally by each of the given denominators, and multiplying the quotients by the respective numerators; the products will be the several new numerators.

But

But as, by abbreviation, fractions are often reduced into much lower terms than they are at first given in; so here, a common *denominator* may sometimes be found much smaller than that arising by the preceding method. The rule therefore for discovering the least common *denominator* to fractions of different denominations, is as follows, *viz.*

R U L E.

Having first, by the fifth sort of reduction, reduc'd all your given fractions to their lowest terms, cancel or strike out all such of the *denominators* as are *aliquot* parts of others; then drawing a line under all the *denominators*, if two or more can be divided by any number, so that nothing may remain, divide by such number; and place the quotients under the line, and with them; in their proper places, all such of the *denominators* as would not admit of such division. If any of the said numbers or *denominators* so brought down, are capable of further abbreviation, draw another line, and proceed as before, so continuing as low as possible; then multiply continually, one into another, the several divisors, and the quotients arising, or numbers remaining under the last line, and their product will be the least common *denominator*. The new *numerators* to which may be found, as before, by dividing the said common *denominator* by each given *denominator*, and multiplying the quotients by their respective *numerators*.

E X A M P L E.

Reduce $\frac{1}{4} \frac{2}{5} \frac{3}{10}$ into one denomination.

Answer, $\frac{10}{40} \frac{8}{40} \frac{3}{40}$.

The common *denominator* 40 is thus produced.

First, The *denominator* 4 being an *aliquot* part of 8, is cancelled; then the *denominators* 8 and 10 are divided by 2. Lastly, The divisor $2 \times 4 \times 5 = 40$.

The

The reason of this sixth sort of reduction is evident from the 2d of the preceding notes; for as both the *numerator* and *denominator* of each given fraction are equally multiply'd by all the other *denominators*, consequently the new fractions thence arising, must be equal to the fractions given.

Seventh, To value a fraction, or reduce it to the known parts of an integer.

R U L E.

Multiply the *numerator* by the next inferior denomination, and divide the product by the *denominator*; the quotient shews the parts sought, and the remainder becomes a new *numerator* to the given *denominator*; which must still be valued by the same rule, proceeding till you have brought it into the least known parts of the integer.

E X A M P L E S.

1st. What's the value of $\frac{3}{10}$ of a pound sterling?

$$\begin{array}{r} 3 \\ 10 \\ \hline 9 \overline{)60} \\ \hline 12 \text{ Shillings.} \end{array}$$

2^d. What's

[150]

2d. What's the value of $\frac{1}{4}$ of a pound sterling?

$$\begin{array}{r}
 13 \\
 20 \\
 \hline
 49 \overline{) 260} \begin{array}{l} s. \\ 5 \end{array} \quad \begin{array}{l} d. \\ 3 \end{array} \quad \begin{array}{l} qrs. \\ 2 \frac{1}{2} \end{array} \text{ facit.} \\
 \underline{245} \\
 15 \\
 12 \\
 \hline
 49 \overline{) 180} \begin{array}{l} s. \\ 3 \end{array} \\
 \underline{147} \\
 33 \\
 4 \\
 \hline
 49 \overline{) 132} \begin{array}{l} s. \\ 2 \end{array} \\
 \underline{98} \\
 34
 \end{array}$$

3d. What hundreds, quarters, and pounds, are contain'd in $\frac{3}{4}$ of a ton?

$$\begin{array}{r}
 53 \\
 20 \\
 \hline
 94 \overline{) 1060} \begin{array}{l} C. \\ 11 \end{array} \quad \begin{array}{l} qrs. \\ 1 \end{array} \quad \begin{array}{l} lb. \\ 2 \frac{1}{2} \end{array} \text{ facit.} \\
 \underline{94} \\
 120 \\
 \underline{94} \\
 26 \\
 4 \\
 \hline
 94 \overline{) 104} \begin{array}{l} C. \\ 1 \end{array} \\
 \underline{94} \\
 10 \\
 28 \\
 \hline
 94 \overline{) 180} \begin{array}{l} C. \\ 2 \end{array} \\
 \underline{188} \\
 92
 \end{array}$$

There

There will be no difficulty in accounting for this rule, if we consider but the particular working of any one example: Thus, in the 1st, $\frac{1}{2}$ of a pound Sterling are given to be valued: Now, as 20 s. make a pound, so consequently any part of a pound must be 20 times as great a part of a shilling; therefore $\frac{1}{2}$ of a pound make $\frac{20}{2}$ of a shilling; which being an improper fraction, its *numerator* is divided by its *denominator*, to find the units or whole numbers (which in this case must be shillings) contain'd in it; according to the directions of the 3d sort of *Reduction*.

By this rule are *remainders* of statings in the *Rule of Three*, &c. valued. See page 26.

ADDITION of FRACTIONS.

WHEN the given fractions are of one denomination, all you have to do, is, to add their *numerators* together, and to place the sum for a new *numerator*, over the *denominator* given; thus, $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{1}{6}$ added together, make $\frac{5}{6}$, or $1 \frac{5}{6}$.

But when amongst the given sums, there are either compound fractions, or single ones of different denominations, they must be prepared by reduction, before they can be added.

EXAMPLES.

1st. What's the sum of $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{1}{6}$?

According to the 6th sort of reduction, the given fractions being brought into one denomination, they will be $\frac{3}{6}$, $\frac{4}{6}$, $\frac{1}{6}$; the *numerators* of which being added, the sum is $\frac{8}{6}$, or $1 \frac{2}{3}$.

2d. Add

2d. Add $\frac{1}{2}$ of $\frac{1}{3}$, and $\frac{1}{5}$ of $\frac{1}{4}$ and $\frac{1}{6}$ together.

Reduce the compound fractions to single ones, by the 4th rule of reduction; and instead of $\frac{1}{2}$ of $\frac{1}{3}$, and $\frac{1}{5}$ of $\frac{1}{4}$, you will have $\frac{1}{6}$ and $\frac{1}{20}$, to add to your $\frac{1}{6}$; all which single fractions being reduced, first into their lowest terms, and then into one denomination, they will be $\frac{1}{12}$, $\frac{1}{12}$, and $\frac{1}{12}$; which added, make $\frac{3}{12}$, or $\frac{1}{4}$.

3d. Add $4\frac{1}{2}$ and $3\frac{1}{4}$ and $\frac{1}{2}$ together.

When mix'd numbers are given to be added, reduce only their fractional parts to one denomination, and add their sum to the total of the whole numbers.

$$\begin{array}{r}
 4\frac{1}{2} \quad 3\frac{1}{4} \quad \frac{1}{2} \\
 \hline
 4 \quad \text{---} \quad 42 \\
 3 \quad \text{---} \quad 14 \\
 \hline
 24 \\
 \hline
 80 \\
 \text{facit } 7 \quad \text{---} \quad 84
 \end{array}$$

More EXAMPLES.

Add $8\frac{1}{2}$ and $3\frac{1}{4}$ and $\frac{1}{2}$ together.

Facit $13\frac{1}{2}$.

What's the sum of $\frac{1}{2}$ of $\frac{1}{3}$, and $4\frac{1}{2}$ and $\frac{1}{3}$?

Answer $5\frac{1}{2}$.

SUBTRACTION of FRACTIONS.

Subtraction of Fractions is also nothing (after the given fractions are prepar'd by reduction) but taking one numerator from the other.

E X A M-

EXAMPLES.

1st. From $\frac{1}{4}$ take $\frac{2}{3}$ 27
16

prepar'd $\frac{3}{8}$ $\frac{1}{8}$ $\frac{1}{8}$ Remainder.

2d. From $5\frac{2}{3}$ take $\frac{1}{3}$.

First, The mix'd number $5\frac{2}{3}$ being reduced to the improper fraction $\frac{32}{6}$, by the second rule of reduction, proceed as before.

From $\frac{32}{6}$ take $\frac{2}{6}$, or prepar'd.

From $\frac{32}{6}$ take $\frac{1}{3}$ Rem. $\frac{16}{6}$ or $4\frac{2}{3}$.

Or without reducing the mix'd number to an improper fraction, make only the fractional parts of one denomination, and you will then have $\frac{2}{3}$ to take from $\frac{2}{3}$; which because you cannot do, you must borrow an unit, i.e. $\frac{2}{3}$; then, $\frac{2}{3}$ from $\frac{2}{3}$, there will remain $\frac{2}{3}$; to which adding the $\frac{2}{3}$, the remainder will then be $\frac{4}{3}$; and the unit borrowed being deducted from the whole number 5, there will remain in all $4\frac{2}{3}$, as before.

More EXAMPLES.

From $5\frac{1}{2}$ take $\frac{1}{2}$ of $\frac{1}{6}$ Rem. $5\frac{1}{6}$.

From $\frac{1}{2}$ take $\frac{1}{3}$ of $\frac{1}{3}$ Rem. $\frac{1}{6}$.

MULTIPLICATION of FRACTIONS.

IF the numbers given are whole, or mixed, they must first be brought into improper fractions; or if they are compound fractions, they must be reduced to single ones; but if the numbers given are both

both either proper or improper single fractions, you have only to multiply the two given *numerators* together for a new *numerator*, and the given *denominators* for a *denominator*.

EXAMPLES.

1st. Multiply $\frac{3}{4}$ by $\frac{1}{2}$, *facit* $\frac{3}{8}$, or by abbreviation $\frac{1}{4}$.

2^d. Multiply $\frac{2}{3}$ by $\frac{3}{4}$, *facit* $\frac{2}{4}$, or $\frac{1}{2}$.

3^d. Multiply 4 by $\frac{1}{2}$. 4 by the first sort of reduction, reduced to a fraction, is $\frac{4}{1}$; which multiply'd by $\frac{1}{2}$, makes $\frac{4}{2}$, or 2 .

4th. Multiply $7\frac{1}{2}$ by $8\frac{3}{4}$. These mix'd fractions, reduced by the 2^d rule of reduction to improper ones, make $\frac{15}{2}$ and $\frac{35}{4}$; which multiply'd together, make $\frac{525}{8}$, or $65\frac{5}{8}$.

Two things require explanation in multiplication of fractions: 1st. Why, when the multiplier is a proper fraction, the product is always less than the multiplicand?

2^d. Why the *denominators* are multiply'd as well as the *numerators*; whereas, in addition, we only find the sum of the *numerators*?

Now the reason why a number multiply'd by a fraction is decess'd, will appear by considering that as an unit is no multiplier, i. e. that any number multiply'd by 1, remains still the same, as once 4 is 4. &c. so to multiply any thing by a fraction, which is but part of 1, must consequently produce but such a proportionable part of the multiplicand, as such fraction is of an unit. Thus 4, multiply'd by $\frac{1}{2}$, produces but 2, the half of 4; which 4, being made a fraction by the 1st rule of reduction, is $\frac{4}{1}$; so that the numbers resolve themselves into a compound fraction; and the product of 4, multiply'd

ply'd by $\frac{1}{2}$, is plainly the $\frac{1}{2}$ of $\frac{4}{2}$; which by the rule for reducing a compound fraction, makes $\frac{2}{2}$, or 2: The reason therefore of the work is clear, from the explanation of the 4th sort of reduction.

More EXAMPLES.

Multiply $9\frac{1}{2}$ by $\frac{2}{3}$, *facit* $3\frac{1}{3}$.

Multiply 3 d. $\frac{1}{4}$ by 3 d. $\frac{1}{3}$, *facit* 14 d. $\frac{1}{10}$.

DIVISION of FRACTIONS.

WHEN you have made the same preparation of your numbers as directed in multiplication, multiply the *denominator* of your divisor by the *numerator* of your dividend, for a *numerator*; and the *denominator* of your dividend, by the *numerator* of your divisor, for a *denominator*.

EXAMPLES.

1st. Divide $\frac{2}{3}$ by $\frac{1}{4}$, *facit* $\frac{8}{3}$, or $2\frac{2}{3}$.

2^d. Divide 7 by $\frac{1}{2}$, prepared by the first rule of reduction, it will be $\frac{7}{1}$ by $\frac{1}{2}$; *facit* $\frac{14}{1}$, or 14 .

3^d. Divide $4\frac{1}{2}$ by $2\frac{1}{3}$, reduced by the 2d rule, it is $\frac{9}{2}$ by $\frac{5}{3}$; which divided, gives $\frac{27}{10}$, or $2\frac{7}{10}$.

4th. Divide $\frac{2}{3}$ of $\frac{1}{2}$ by $\frac{1}{4}$ of $\frac{1}{3}$, reduc'd by the 4th rule, $\frac{2}{3}$ by $\frac{1}{4}$, *facit* $\frac{8}{3}$.

There is nothing in the whole practice of fractions, that more requires an explanation, than the manner of performing division, so different from that of whole numbers. Now, as the effect of division is the finding how often one number is contain'd in another; or, which is the same thing, what part of the dividend the divisor

divisor is; so it is plain, that if the divisor is unity or 1, the quotient must be equal to the dividend; consequently, in what proportion soever the divisor exceeds unity, in such proportion must the quotient be less than the dividend; and in what proportion soever the divisor is less than unity, by the same proportion must the quotient exceed the dividend. Thus, suppose the number 4 was given for a dividend, if 1 is proposed for its divisor, the quotient will be also 4; but if we make the dividend 2, twice the former divisor, the quotient will be but 2, half the former quotient. Again, let the divisor be $\frac{1}{2}$, i. e. half of 1, and the quotient will then be 8, or 8, twice as much as the first quotient, as the divisor is here but half the first divisor. From whence appears the reason,

1st. Why dividing a number by a proper fraction gives a quotient greater than the dividend: as multiplying a number by a fraction was before prov'd to give a product less than the multiplicand.

2^d. Why the operation is to be perform'd in the manner directed; for, as the greater the *denominator* is, the less is the value of the fraction; and consequently that the quotient must increase in the same proportion, is a clear reason for multiplying the *numerator* of the dividend by the *denominator* of the divisor, for the *numerator* of the quotient: so in like manner, as the increase of the *numerator* of a fraction is the increase of the value of such fraction, it is therefore as plain, the value of the quotient must be diminished in the same proportion, by the increase of its *denominator*; which is certainly effected by multiplying the *denominator* of the dividend by the *numerator* of the divisor. Thus $\frac{2}{3}$, divided by $\frac{1}{4}$, gives $\frac{8}{3}$; but divided by $\frac{2}{3}$, gives but $\frac{4}{3}$; the value of the quotient still decreasing in the same proportion with the increase of the value of the divisor.

More EXAMPLES.

Divide $\frac{1}{2}$ by $\frac{1}{3}$. *Quot.* $2\frac{1}{3}$.
Divide $9\frac{1}{2}$ by $\frac{1}{4}$ or $\frac{1}{2}$. *Quot.* $31\frac{1}{2}$.

The DIRECT RULE of THREE IN VULGAR FRACTIONS.

After the numbers are prepared by reduction, state and work the question by the rules given in whole numbers.

EXAMPLES.

1st. What will $\frac{1}{2}$ a pound of snuff cost, if 22 lb. $\frac{1}{2}$ of the same come to 7 l. $\frac{1}{3}$?

lb.	l.	lb.
If 22 $\frac{1}{2}$ cost	7 $\frac{1}{3}$,	what will $\frac{1}{2}$?

Prepar'd by the 2d rule of reduction, it will stand thus:

If $22\frac{1}{2} \dots 22\frac{1}{2} \dots \frac{1}{2}$

then the second and third numbers multiply'd together produce $22\frac{1}{2}$; which divided by $22\frac{1}{2}$, gives $\frac{1}{2}$; which valu'd by the 7th rule of reduction, is 3 s. 3 d. 2 gr. $\frac{1}{4}$.

2d. Bought 87 gallons and an $\frac{1}{2}$ of brandy for 40 l.
at the same rate, what would $\frac{1}{2}$ a gallon cost?

$$\begin{array}{r}
 \text{Gall.} \qquad \text{l.} \qquad \text{Gall.} \\
 \text{If } 87 \frac{1}{2} \text{ cost } 40, \text{ what will } \frac{1}{2} \text{?} \\
 \text{prepar'd } 17 \frac{1}{2} \overline{) 40} \quad \frac{1}{2} \\
 \hline
 \text{then } 40 \times 1 = 40 \cdot \div 17 \frac{1}{2} = 3 \frac{28}{35} = 3 \frac{4}{5}, \text{ or } 4 \text{ } 6 \text{ } 3 \frac{4}{5}
 \end{array}$$

Another RULE.

When your question is stated, and your numbers prepared, multiply the *denominator* of the first number by the *numerators* for the second and third, and place the product for a *numerator*: Then multiply the *numerator* of the first number by the *denominators* of the second and third, and place the product for its *denominator*; and the new fraction so found, is the answer of the question. Take the stating of the last question, for an

EXAMPLE.

$$\text{If } 17 \frac{1}{2} \cdot \cdot \frac{40}{1} \cdot \cdot \frac{1}{2} \text{ facit } 3 \frac{28}{35}.$$

For 2, the *denominator* of the first number, multiply'd by 40 and 1, the *numerators* of the second and third numbers, is 80.

And 175, the *numerator* of the first, multiply'd by 1 and 2, the *denominators* of the second and third, is 350. These products, plac'd fractionally, make $3 \frac{28}{35}$, as before.

3d. What will 82 C. of sugar come to, if $\frac{1}{4}$ of $\frac{1}{8}$ of a C. costs $\frac{9}{10}$ of a pound Sterling?

$$\begin{array}{r}
 \text{C.} \qquad \text{l.} \qquad \text{C.} \\
 \text{If } \frac{1}{4} \text{ of } \frac{1}{8} \text{ cost } \frac{9}{10}, \text{ what will } 82 \text{?} \\
 3 \frac{1}{2} \cdot \cdot \frac{9}{10} \cdot \cdot \frac{82}{1} \\
 \text{Facit } 21 \frac{14}{10}, \text{ or } 26 \text{ l. } 8
 \end{array}$$

More

More EXAMPLES.

What will $\frac{1}{4}$ of an ounce of snuff cost, if the lb. comes to 8 s. $\frac{1}{2}$?

Answer, 1 d. 2 qrs. $\frac{1}{4}$.

At 1 d. $\frac{1}{2}$ per ounce, what will 5 C. $\frac{1}{2}$ come to?

Answer, 61 l. 12 s.

The INDIRECT RULE of THREE IN VULGAR FRACTIONS.

HERE also you have only to observe the directions given in whole numbers:

Or this RULE.

After the numbers are stated and prepared, multiply the *numerators* of the first and second numbers by the *denominator* of the third, for a *numerator*; and the *denominators* of the first and second, by the *numerator* of the third number, for a *denominator*; and the fraction so found, is the *Answer*. See both ways in the example.

EXAMPLE.

How many yards of stuff, $\frac{1}{2}$ yard wide, are equal to 36 $\frac{1}{2}$ yards of $\frac{1}{4}$ wide?

$$\begin{array}{l} \text{If } \frac{1}{4} \longrightarrow 36 \frac{1}{2} \longrightarrow \frac{1}{2} \\ \text{Prepar'd } \frac{1}{4} \dots\dots \frac{1+1}{2} \dots\dots \frac{1}{2} \\ \frac{1}{4} \times 141 = \frac{141}{4} \div \frac{1}{2} = 141 \div 2 = 70 \frac{1}{2}, \text{ or } 70 \frac{1}{2}. \end{array}$$

So also 3, 145, and 2, the *numerators* of the first and second numbers, and the *denominator* of the third, multiply'd together, is 870.

And 4, 4, and 1, the *denominators* of the first and second, and *numerator* of the third, multiply'd together, produce 16.

These numbers, fractionally plac'd, make $\frac{870}{16}$, as before.

More EXAMPLES.

If A. lends B. 35 $l.$ $\frac{1}{2}$ for 6 months $\frac{1}{2}$, how long may he keep 10 $l.$ $\frac{1}{2}$ of B's, to require himself?

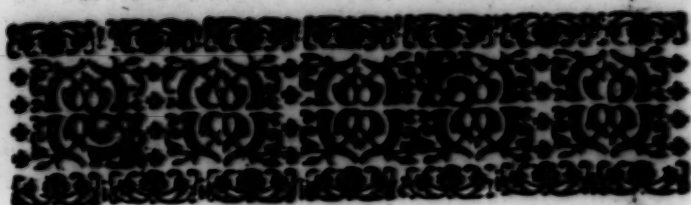
Answer, 16 months, $2\frac{1}{2}$.

If A. keeps 100 $l.$ $\frac{1}{2}$ of B's 4 months $\frac{1}{2}$, what sum must A. lend B. for 2 years $\frac{1}{2}$ to require him?

Answer, 14 $l.$ $7\frac{1}{2}$.

The End of the first Part.





THE
SECOND PART:
TREATING OF
Decimal Arithmetic.

THIS part of Arithmetic is very compendious, and therefore very useful, especially in calculations of interest, valuing annuities, &c. But by reason some fractions of coin, weight, and measure, cannot be exactly express'd by decimal parts, but that the numbers will often circulate, it is not always convenient to work with them. Mr. Cunn hath, indeed, in his late treatise on fractions, very curiously shewn how they may be used with least loss; but since such exactness destroys the brevity, I cannot but think, in such cases, vulgar fractions preferable.



C H A P. I.

Of NUMERATION, ADDITION, SUBTRACTION, MULTIPLICATION, and DIVISION of DECIMALS.

N U M E R A T I O N .

IN DECIMAL FRACTIONS, the *integer*, or whole thing, (whether it be time, coin, weight, or measure, as one year, one pound Sterling, one pound weight, &c.) is supposed to be divided into tenths, or ten equal parts; and those parts again into tenths, and so on, *ad infinitum*.

So that the *denominator* of a decimal fraction being always known to consist of an unit, with as many cyphers as the *numerator* hath places, is seldom set down; the parts being only distinguish'd from whole numbers, by a point, or comma, prefix'd; thus, .5 stands for $\frac{5}{10}$, .25 for $\frac{25}{100}$, .123 for $\frac{123}{1000}$, &c.

But the different value of the several places, will more plainly appear from the following Table.

T A B L E.

Whole Numb.							Decimal Parts.						
6	5	4	3	2	1		2	3	4	5	6	7	
Units. Ten. Hundreds. Thousands. C Thousands. &c.							Parts of 10 Parts of 100 Parts of 1000 Parts of 10000 Parts of 100000 Parts of 1000000 &c.						

From

From whence it is evident,

1st. That as whole numbers increase by a tenfold proportion towards the left hand, from the unit's place; so decimal parts decrease, in the same proportion, towards the right.

2^d. That therefore cyphers, placed before decimal parts, decrease their value, by removing them farther from the comma, or unit's place.

Thus, $\left\{ \begin{array}{l} .5, \text{ is } 5 \text{ parts of ten, or } \frac{5}{10}. \\ .05, \text{ is } 5 \text{ parts of an hundred, or } \frac{5}{100}. \\ .005, \text{ is } 5 \text{ parts of a thousand, or } \frac{5}{1000}. \end{array} \right.$

3^d. But that cyphers, after decimal parts, alter not their value, because they do not change their places.

For .5, .50, .500, &c. are each but $\frac{5}{10}$ of an unit or 1; the 5 still keeping its first place.

These things understood, the rest is easy: But let the reader be sure he does understand them, before he proceeds.

A D D I T I O N.

HAVING set down your proposed numbers, units under units, tens under tens, and parts un'er parts of like value, add them as if they were all whole numbers, separating so many decimal parts in the total, as were in any of the given numbers.

EXAMPLES.

Add 5.42, and 38.583, and 421.06, and .8345 together.

<i>These numbers,</i>	5.42
<i>rightly plac'd,</i>	38.583
<i>will stand thus:</i>	421.06
	.8345
Total,	465.8975

	<i>l.</i>	<i>l.</i>	<i>l.</i>
What's the sum of	4.06,	and 21.734,	and 523.8642
			21.734
			4.06

Answer, 549.6582 *l.*

SUBTRACTION.

HAVING plac'd the numbers as directed in addition, work still as if they were all whole numbers.

EXAMPLES.

	<i>l.</i>	<i>l.</i>
From	839.38275	take 10.49561
	10.49561	

828.88714 *Remainder.*

<i>Yards.</i>	<i>Yards.</i>
Take 23.279	from 451.15842
	23.279

Remains, 427.87942

MULTI-

M U L T I P L I C A T I O N .

Here the numbers are to be set down, (without regard to the value of their places) and work'd in all respects the same as in whole numbers; only observe to separate so many places of decimal parts on the right hand of the product, as were in both multiplicand and multiplier.

E X A M P L E S .

Multiply 2,735641
by .54382

$$\begin{array}{r}
 5471282 \\
 21 \ 885128 \\
 82 \ 06923 \\
 1094 \ 2564 \\
 13678 \ 205 \\
 \hline
 1,4876 \ 9628361
 \end{array}$$

Multiply 73,82564365
by 8,7434592

$$\begin{array}{r}
 14765128730 \\
 66443079285 \\
 3 \ 6912821825 \\
 29 \ 530257460 \\
 221 \ 47693095 \\
 2953 \ 0257460 \\
 51677 \ 950555 \\
 590605 \ 14920 \\
 \hline
 \text{Product } 645,491 \ 503167514080
 \end{array}$$

A compendious way to multiply numbers that have many decimal places; by omitting all the figures to the right of the perpendicular lines in the examples above.

R U L E .

Place one of the numbers just as it is given, for a multiplicand, and under that decimal place which you would have be the last in the product, set the unit's place of your other number; then reversing all the other figures, multiply with them in their order, beginning always with that figure of the multiplicand, which stands over the number you work with; having also respect to the increase you think would have

H f

been

been brought from the omitted figures on the right hand, had they been multiplied.

Note, The usual allowance for such omitted figures is as follows, viz. If the next figure on the right hand of that you begin with in the multiplicand, multiply'd into the figure of the multiplier you are working with, gives a product betwixt 5 and 15, carry 1; if the product be above 15, and less than 25, carry 2; and if it arise to any number betwixt 25 and 35, carry 3, &c.

To prove the certainty of the rule, we will take the same examples before given.

E X A M P L E S.

Multiply 2,735641 by ,54382, and produce only four places of decimals.

$$\begin{array}{r} 2,735641 \\ 28349,0 \\ \hline \end{array}$$

13678 the Increase here carried is 3 for 5x6
1094 the Increase here is 2 for 4x5
82 the Increase here is 1 for 3x3
22 the Increase here is 6 for 8x7

$$\begin{array}{r} 1,4876 \\ \hline \end{array}$$

Note, There being no units in the multiplier, its place is supply'd with a cypher.

Multiply 73,82564365 by 8,7434592, and produce but 3 places of decimals.

$$\begin{array}{r} 73,82564365 \\ 2954347,8 \\ \hline \end{array}$$

$$\begin{array}{r} 590605 \\ \hline \end{array}$$

$$\begin{array}{r} 51678 \\ \hline \end{array}$$

$$\begin{array}{r} 2953 \\ \hline \end{array}$$

$$\begin{array}{r} 222 \\ \hline \end{array}$$

$$\begin{array}{r} 29 \\ \hline \end{array}$$

4 the Increase carried for 5x7

$$\begin{array}{r} 645,491 \\ \hline \end{array}$$

Note

Notes. To multiply any decimal number by 10, 100, 1000, &c. is only to remove the mark of separation so many places towards the right hand as there are cyphers.

$$\text{Thus, } 8.3564537 \left\{ \begin{array}{l} 10, \\ 100, \\ 1000, \\ 10000, \end{array} \right\} \text{ is } \left\{ \begin{array}{l} 83.564537 \\ 835.64537 \\ 8356.4537 \\ 83564.537, \&c. \end{array} \right.$$

D I V I S I O N.

THIS rule also being work'd the same as in whole numbers, the only difficulty is to value the quotient; which may be done by either of the following general rules, viz.

R U L E 1.

The first figure in the quotient is always to stand in the same place with that figure of the dividend, which answers, or stands over the place of units in the divisor. Or,

R U L E 2.

The quotient must always have so many decimal places, as the dividend has more than the divisor.

Notes. 1st. If the divisor and dividend have both the same number of decimal parts, (as in the second example) the quotient will be all a whole number.

2^d. If the dividend hath not so many places of decimals as are in the divisor, (as in example the 3^d.) so many cyphers must be annex'd to the dividend, as will make them equal; and the quotient will then, as before, be all a whole number.

3^d. But if, when division is done, the quotient has not so many figures as it should have places of decimal parts, (as in the last example) so many cyphers must be prefix'd, as there are places wanting.

EXAMPLES.

1st. Divide 10,55439 by 4,569

$$4,569 \overline{) 10,55439} (2,31$$

$$\underline{14163}$$

$$\underline{4569}$$

...

Here, according to the first rule, 4, the unit's place of the divisor, standing under units, or the first place of whole numbers in the dividend; 2, or first figure plac'd in the quotient, must also be made the first place of whole numbers, by placing the point of separation immediately after it.

Or, according to the second rule, there being five places of decimals in the dividend, and but three in the divisor; two places must be separated off in the quotient, to make up the number.

Ex. 2^d. Divide 85643,825 by 6,321.

$$6,321 \overline{) 85643,825} (13549$$

$$\underline{22433}$$

$$\underline{24708}$$

$$\underline{31032}$$

$$\underline{57485}$$

$$\cdot 596$$

Here 6, the place of units in the divisor, standing under 8, the fifth place of the whole numbers in the dividend,

dividend, 1, the first figure of the quotient, must also stand in the same place, which makes all the quotient whole numbers.

And so it must also be by the second rule, because the dividend has no more places of decimals than the divisor.

Ex. 3. Divide 7382,54 by 6,4352.

$$6.4352 \overline{) 7282.5400} \cdot 1147$$

Here there not being so many places of decimals in the dividend as in the divisor, two cyphers are added to make them even; and being so, the quotient is all a whole number as before.

Ex. 4. Divide ,08516438 by 423.

$$423 \overline{) 0.08516438} \cdot 00020133$$

$$\begin{array}{r} 564 \\ \hline 1413 \\ \hline 1448 \\ \hline 179 \end{array}$$

In this example, the quotient consisting but of five figures, whereas there should, by the rules, be eight places of decimal parts, three cyphers are prefixed to make up the number, as was directed in *Note the third*.

There is also a way of contracting the work of a large division, somewhat like that compendious method before taught, of multiplying numbers of many places of decimals, and bringing out only so many in the product as are necessary for the answer required.

R U L E.

Having consider'd, by the first rule given for valuing the quotient, in what place the first figure thereof ought to stand, and accordingly determined how many figures it is necessary it should consist of, you may from thence judge whether any, or how many of the right hand figures of your divisor may be neglected; so that reserving only so many figures of the dividend as are necessary for once answering the divisor, cut off the rest to the right hand as useless; and having set the proper figure in the first place of the quotient, work with it as usual; then omitting the right hand figure of your divisor, seek how often the other figures of your divisor are contained in the remainder; which figure being enter'd in the quotient, and work'd with as usual in division, (with regard, however, to the carriage that would have been brought from the omitted figures, as before directed in multiplication) thus continuing to neglect the right hand figure of your divisor every time you seek a new quotient figure, you will still be able to divide the remainder left after the last subtraction by the divisor so lessened, till you have brought out the determin'd number of figures in the quotient.

The following example, which is set down both at length, and the contracted way, will make all clear.

E X A M-

[171]

EXAMPLE

3.46375(28)95.4327|56463275(27.55183
69275056

261577004
242462696

191143086
173187640

179554463
173187640

63668232
34637528

290307047
277100224

132068235
103912584

128155651

3.46375(28)95.4327|56463275(27.5518

..... 692750

261577
242463

19114
17319

1795
1732

63
35

28
26

2

And

And thus are all the figures on the right hand of the perpendicular line in the example work'd at length, sav'd by working after this contracted manner.

As multiplying by 10, 100, 1000, &c. is only removing the separating point of the multiplicand, so many places towards the right hand as there are cyphers in the multiplier; so, to divide by 10, 100, 1000, &c. is only removing the mark of separation, after the same manner, towards the left hand.

$$\text{Thus } 83564.537 \left\{ \begin{array}{l} 10, \\ 100, \\ 1000, \\ 10000, \end{array} \right\} \text{ is } \left\{ \begin{array}{l} 8356.4537 \\ 835.64537 \\ 83.564537 \\ 8.3564537 \end{array} \right.$$

These examples being, I hope, sufficient to make division plain, we will now proceed to *Reduction of Decimals*.





C H A P. II.

Of REDUCTION of DECIMALS.

THERE are two sorts of *Reduction of Decimal Fractions*. 1st. Changing a vulgar fraction to a decimal. 2. Valuing a decimal by the known parts of an integer.

1st. To reduce or change a vulgar fraction to a decimal.

R U L E.

Place cyphers at pleasure after the *numerator*, and divide by the *denominator*.

E X A M P L E S.

Reduce $\frac{1}{4}$ to a decimal, $4)1,00(.25$ *facit*.

What decimal parts are equal to $\frac{1}{8}$?

$8)3,000(.375$ *facit*.

And so any part of coin, weight, measure, or time, &c. may be brought into a decimal, by first reducing it into a vulgar fraction, (which is done by placing the known parts of the integer as a denominator under the parts given) then annexing cyphers to the *numerator*, and dividing by the *denominator*, as before directed.

E X A M-

EXAMPLES.

What decimal parts of a pound are equal to 16 s.?

i. e. $\frac{1}{13}$ 20) 16,0(8 *factis.*

What's the decimal of 9 oz. the inter a lb. Troy?

i. e. $\frac{1}{2}$ 12)9,00(.75 facit.

Note. If the given parts are of several denominations, they may be reduced either by so many distinct operations as there are different parts, or by first reducing them into their lowest denomination, and then one division will serve. See both ways in the

EXAMPLES.

Reduce 14 s. 9 d. $\frac{1}{4}$ into decimal parts of a pound Sterling: By the first way there will be these three vulgar fractions to be chang'd, $\frac{1}{10}$, $\frac{1}{20}$, and $\frac{1}{40}$.

20) 14,00(,70

240).90000(.0375

.70

0375

,0031

960)3,0000(0031

1800

1360

7406

1200

340

60

24

The other way. $14\ 9\frac{1}{2}$ being reduc'd to farthings.

12

177

4

will be 711

which divided
by its deno-
minator,

960)711,0000(.7406 is produc'd as
 (before.

3900

• 6000

240

What

What decimal parts of a C. are equal to 3 qrs. 18 lb.?

By the first way:

$$\begin{array}{r}
 \frac{1}{2} \text{ and } \frac{1}{4} \text{ 4) } 3,00,75 \\
 \underline{1,607} \\
 ,9107 \text{ facit.}
 \end{array}
 \qquad
 \begin{array}{r}
 112)18,0000(.1607 \\
 \underline{1120} \\
 680 \\
 \underline{672} \\
 800 \\
 \underline{784} \\
 16
 \end{array}$$

By the second way:

$$\begin{array}{r}
 \text{qrs. lb.} \\
 3 \quad 18 \\
 28 \\
 \hline
 102 \\
 \hline
 112 \text{ Denominator.}
 \end{array}
 \qquad
 \begin{array}{r}
 112)102,0000(.9107 \\
 \underline{1120} \\
 120 \\
 \underline{1120} \\
 800 \\
 \underline{784} \\
 16
 \end{array}$$

There is also another way of reducing parts of different denominations into decimals of the highest integer; thus,

R U L E.

Bring the lowest parts into decimals of the next superior denomination; and on the right hand of the decimal found, place the parts given of that said next superior denomination; so proceeding, till you bring out the decimal parts of the highest integer requir'd, by still dividing the product by the next superior denominator; for examples, take those before given, viz.

Reduce

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Reduce 14*s.* 9*d.* $\frac{1}{2}$ into decimal parts of a pound Sterling.

$$\begin{array}{r} 4 \overline{) 3.} \\ 12 \overline{) 9.75} \\ 20 \overline{) 14.8125} \\ \hline .7406 \end{array}$$

Here the 3 farthings being divided by 4, gives 75, to which the 9*d.* being prefixed, it becomes 9.75; which divided again by 12, quotes .8125; before which the 14*s.* being also placed, it makes 14.8125; which being lastly divided by 20, the quotient .7406, is the answer.

What decimal parts of a C. are equal to 3 *qr.* 18 *lb.*?

$$\begin{array}{r} 28 \left\{ \begin{array}{l} 7 \overline{) 18.} \\ 4 \overline{) 2.5714} \\ 4 \overline{) 3.6428} \\ \hline .9107 \end{array} \right. \end{array}$$

Note, Instead of dividing by 28, which would be troublesome; 'tis better to divide by 7 and 4, as in the example, 4 times 7 being 28.

Thus you see how easily the decimals, answering to any given parts of coin, weight, measure, &c. are found; and after the same manner are the following tables formed.

But shillings, pence, and farthings, may more readily be reduc'd thus:

R U L E.

For the shillings, (if their number be even) set down their half in the first place of decimals, and let the second and third places be fill'd up with the farthings contain'd in the remaining pence and farthings, always remembering to add one, when the number is or exceeds 25; but

but if the number of shillings be odd, the second place of decimals must also be increased by 5.

Thus the decimal of 8*s.* 5*d.* $\frac{1}{2}$, will be .422, 4 in the first place of decimals standing for 8*s.* and 22 farthings being 5 $\frac{1}{2}$.

Again, 8*s.* 6*d.* $\frac{1}{2}$ will be .427.

1 being added to 26, the number of farthings in 6*d.* $\frac{1}{2}$, because exceeding 25.

But, lastly, 9*s.* 6*d.* $\frac{1}{2}$ will be thus express'd by decimals, viz. .477.

5 being added to the second place, because the number of shillings is odd, the decimal of 1 shilling being .05.

The second sort of reduction, is to value a decimal by the known parts of its integer; which is thus done:

R U L E.

Multiply the decimal given by the known parts of the next inferior denomination, and ordering the product as directed in multiplication, still multiply the remaining decimals by the known parts of the next inferior denomination; thus proceeding till you have brought it into the least known parts of the integer, the figures standing on the left of the separating points, will be the parts required.

E X A M P L E S.

Ex. 1. What's the value of .7691, the integer a pound Sterling? (i.e.) What shillings, pence, and farthings, are equal to .7691 parts of a pound Sterling?

<i>multiply'd by</i>	<u>.7691</u>	<i>parts of a pound</i>
		20 <i>the shillings in 1 l.</i>
<i>produce shillings</i>	<u>15,3820</u>	<i>and parts of a shill.</i>
<i>which multiply'd by</i>		12 <i>the pence in 1 shill.</i>
<i>make pence</i>	<u>4,5840</u>	<i>and parts of a penny.</i>
<i>which again multiply'd by</i>		4 <i>the farthings in 1 d.</i>
<i>give farthings</i>	<u>2,3364</u>	<i>and part of a farth.</i>
		So

So that the value of .7691 decimal parts of a pound Sterling, is 15 s. 4 d. $\frac{1}{2}$.

Ex. 2. What ounces, penny-weights, and grains, are equal to .84362 decimal parts of a pound Troy?

<i>multiply'd by</i>	<i>.84362 parts of a pound Troy, 12 the ounces in one pound,</i>
<i>give ounces</i>	<i>10,12344 and parts of 1 ounce.</i>
<i>multiply'd by</i>	<i>20 the penny-weights in 1 oz.</i>
<i>give penny-weights</i>	<i>2,46880 and parts of 1 penny-wt.</i>
<i>multiply'd by</i>	<i>24 the grains in 1 penny-wt.</i>
	187520
	93760
<i>Give grains</i>	<i>11,25120 parts of 1 grain.</i>

The Answer therefore is 10 oz. 2 dwts. 11 grs.

But the decimal parts of a pound Sterling may be thus valued at sight:

R U L E.

The figure standing in the first place of decimals doubled, gives shillings; but if the figure in the 2d place is or exceeds 5, one more must be added to their number; the second figure, (if under 5) or its excess, (if above 5) join'd with the third, are so many farthings; only remember to abate 1, if their number amounts to 25; or 2, if near 50.

The reason of this abatement is, that as 1000 is the denominator of every decimal consisting of 3 places, so consequently by reckoning the figure standing in the said third place, as so many farthings, we thereby allow 1000 farthings to the pound; whereas indeed there are but 960: The overplus therefore being 40 in 1000, is

is certainly 4 in 2 100, or 1 in 25, &c. according to the direction above.

EXAMPLES.

Ex. 1. What's the value of ,375 parts of a pound Sterling?

Answer, 7 s. 6 d.

The 3 doubled is 6 shillings; to which 1 s. being added for the 5, in the second place, makes it 7 s. and 2 remaining, join'd with the 5 in the 3d place, being accounted 25 farthings, from which 1 being deducted, there remain 24 farthings, or 6 pence.

Ex. 2. What's the value of ,846 parts of a pound?

Answer, 16 s. 11 d.

The 8 doubled, making 16 s. and 2 abated from the 46 farthings, leaves 44 farthings, or 11 d.

Thus are shewn the ways both of finding the decimals answerable to any given parts of coin, weight, measure, &c. or the value of any given decimal in the known parts of its integer.

I have likewise annexed TABLES ready calculated by the foregoing rules, answering to the same ends.

The use of which is very plain; one column in each table, containing the number of shillings, ounces, drachms, pints, bushels, days, hours, or any thing else you may want; and against the said number, in the other column, the decimal parts answering: Thus against 3 pence in the first table, is found .0125, and against 40 days in the fourth table, 109589.

But if the number you want is not to be found in the said tables, (many compound numbers having been omitted, to reduce them into so narrow a compass) you must add the parts of such two or three numbers together, as will compose it, and the total will be the decimal sought. Thus, if the decimal of 17 penny-weights, the integer a pound Troy, were to be sought in the 2d table, .04166, the decimal of 10 penny-weights, and .019166, the decimal of 7 penny-weights, being added together, the total .070832, will be found the answer; or, if in table the fourth, you would find the decimal of 352 days,

$$\begin{array}{rcl}
 \text{Add } .821918 & \left. \begin{array}{l} \text{the} \\ .136986 \\ .005479 \end{array} \right\} \text{Decimals} & \left\{ \begin{array}{l} 300 \\ 50 \\ 2 \end{array} \right\} \text{Days.} \\
 \hline
 \text{total } .964318 & \text{answering} & 352 \text{ days.}
 \end{array}$$

And so of any other.



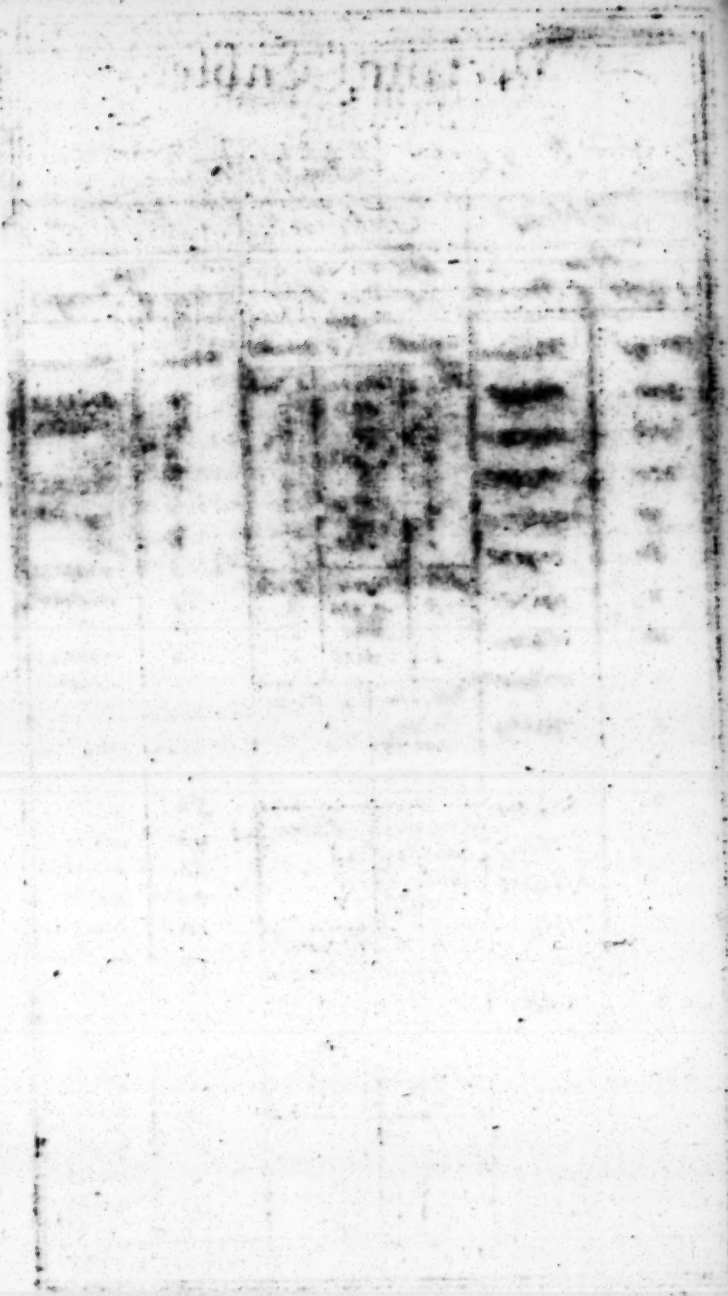
Secord & Co.
Coin & Weight

Walter J. Brown

Not done - Confused

Decimal Tables of Measure and Time

Table 4. th		Table 5. th			Table 6. th	
Time 1 year of Solar		Measure Liquid Dry Sugar			Time Day of Solar	
Days	Decimal	Quarts	Pints	Fluid Ounces	Hours	Decimal
300	.008203	7	4	2	20	.000457
200	.005469	5	2	1	10	.000228
100	.002734	2	1	6	5	.000114
90	.024670	1	6	3	7	.000228
80	.021936	1	6	3	6	.000114
70	.019202	1	6	3	5	.000228
60	.016468	1	6	3	4	.000114
50	.013734	1	6	3	3	.000228
40	.010999	1	6	3	2	.000114
30	.008265	1	6	3	1	.000228
20	.005531	1	6	3		
10	.002797	1	6	3		
9	.024607	1	6	3		
8	.021918	1	6	3		
7	.019278	1	6	3		
6	.016638	1	6	3		
5	.013999	1	6	3		
4	.011359	1	6	3		
3	.008719	1	6	3		
2	.006079	1	6	3		
1	.003439	1	6	3		
Within first		Within first			Within first	





CH A P. III.

Of the RULE of THREE.

THIS *Rule of PROPORTION* having been already sufficiently explained, both as to its nature and operation in *Vulgar Arithmetic*, 'tis needless to repeat here what has been there said. Only therefore observe, that instead of preparing your numbers, by reducing them into their lowest denomination, you must now bring their fractional parts into decimals. See the examples.

E X A M P L E S.

Ex. 1. If the price of 26 yards and $\frac{1}{2}$ of drugget is 3*l.* 16*s.* 3*d.* what will 32 yards $\frac{1}{2}$ come to?

The fractional parts of the numbers being reduced to decimals, and the question stated as usual, the work will stand as follows:

Yards. *l.* *Yards.*
 If 26,5—3,8125—32,25
 32,25

190625
 76250
 76250
 114375

26,5)122,953125(4,63974 } *The quotient valued*
 1695 } *by the short rule for*
 money, makes 4l. 12s.
 9d.4

1053
 2581
 1962
 1075
 15

Ex. 2. What will the pay of 540 men amount to,
 at 1 l. 5s. 6d. per man?

Man. *l.* *Man.*
 If 1—1,275—540

540
 51000
 6375

Answer, 688,500 or 688 l. 10s.

For more examples, take those given in *Vulgar Arith-*
metic.

The Indirect Rule of THREE.

THE Indirect Rule of THREE is also the same here as in *Vulgar Arithmetic*, differing only in the preparation of the numbers.

EXAMPLE.

What must the penny-loaf weigh, when wheat is 10 s. the bushel, if, when at 6 s. 8 d. per bushel, the penny loaf weighs 5 oz. $\frac{1}{2}$?

$$\begin{array}{r}
 \text{If } .33333 \text{ --- } 5.5 \text{ --- } 5 \\
 \quad \quad 5.5 \\
 \hline
 \quad 166665 \\
 \quad 166665 \\
 \hline
 .5)1.833315(\\
 \quad \quad 3.66663
 \end{array}$$

oz. dwt. grs.
 Answ. 3 13 7

Take also one Example in the DOUBLE RULE.

If the carriage of $\frac{1}{2}$ a C. wt. 40 miles comes to 6 d. what will be the charge of carrying 16 C. $\frac{1}{2}$ 100 miles?

First, If .5 ——— .025 ——— 16,25

,025

8125

3250

,5)40625(

Miles

Then, If 40 ——— ,8125 ——— 100

100

40,81,2500(

facit 2,03125

or

2 l. 0 s. 7 d. $\frac{1}{2}$.





CHAP. IV.

Of PRACTICE.

SOME questions in this rule may also be advantageously work'd by decimals; as,

1st. When the given price is just two shillings, 'tis only separating the right hand figure for a decimal, the rest are pounds: So in the

EXAMPLE.

5293 lb. at 2 s. per lb. comes to $\left\{ \begin{array}{l} 529,5 \\ \text{or} \\ 529 \text{ l. } 10 \text{ s.} \end{array} \right.$

2^d. When the price is any aliquot part of 2 s. it is only separating the right hand figure, as before, and then dividing the number by such part.

EXAMPLE.

oz. d.
258,3 at 8 per oz.

l. s.
8 d. $\frac{1}{2}$ 86,1 facit, or 86 2

3^d. When the given price can be divided into aliquot parts of two shillings, separate as before, and take such parts.

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EXAMPLE.

	lb.	d.
	563.8	at 9 per lb.
d.	<u> </u>	
	6 $\frac{1}{2}$	140.95
	3 $\frac{1}{2}$	<u>70.475</u>
facit 211.425 or 211 l. 8 s. 6 d.		

4th. When the price is any number of shillings whatsoever, 'tis only multiplying by their half, (which is the decimal of them) and the product is the answer.

EXAMPLES.

lb.	s.	oz.	s.
7296	at 12 per lb.	8264	at 15 per oz.
.6		.75	
<u> </u>		<u> </u>	
facit 4377.6 or 4377 l. 12 s.		41320	
		<u>57848</u>	
		l. 6198.00 facit.	

5th. The requir'd price of any quantity may be found, by multiplying the said quantity by the decimal of the price given.

EXAMPLE.

lb.	l.	s.	d.
8397	at 5	13	6 per lb.
5.675			
<u> </u>			
41985			
58779			
50382			
<u>41985</u>			
facit 47652.975 or 47652 l. 19 s. 6 d.			

6th. If

6th. If there are fractional parts in the given quantity, they must be reduced to decimals, as well as the fractional parts of the price; as in the following

EXAMPLES.

lb. s.
368 $\frac{1}{2}$ at 13 per lb.

368,5
.65

18425
22110

facto 239,525

or
239 l. 10 s. 6d.

C. qrs. lb. l. s. d.
7368 3 14 at 1 12 6

7368,875
1,625

36844375

14737750

44213250

7368875

facto 11974,421875

or
11974 l. 8 s. 5 d. $\frac{1}{2}$

The questions proposed in *Vulgar Arithmetic*, will here also serve for more examples.





C H A P. V.

Of INTEREST *and* REBATE.

THESE rules having been already sufficiently explain'd in *Vulgar Arithmetic*, it only now remains to shew how much more advantageously they may be work'd by decimals. And, *first*,

SIMPLE INTEREST.

1st. THE annual interest of any sum of money is found by only multiplying the given principal by the interest of one pound for a year; which,

$$\text{at } \left\{ \begin{array}{l} 4 \\ 5 \\ 6 \end{array} \right\} \text{ per Cent. is } \left\{ \begin{array}{l} ,04 \\ ,05 \\ ,06 \end{array} \right.$$

found by dividing the rate of interest by 100,

E X A M-

EXAMPLES.

1st. What's a year's interest of $\overset{L}{536}$ at $\overset{L}{5}$ per Cent. p. .05

facit 26,80 or 26 l. 16 s.

2^d. What will the interest of 2367 l. come to in a year, at 6 l. per Cent. per Ann. p. .06

facit 142,02 or 142 l. 0 s. 5 d.

3^d. Thus a year's interest of any sum being found, 'tis only multiplying that sum by 2, 3, 4, &c. and the product is the interest of the said sum, for 2, 3, 4, or more years.

EXAMPLE.

What's the interest of $\overset{L}{623}$ for 3 years, at 4 per Cent. p. .04

24,92 Interest for 1 year.

3

74,76 } Interest for 3 years.
or
74 l. 15 s. 2 d. $\frac{1}{2}$

3^d. Again, If the time requir'd be months, 'tis only dividing the year's amount by such parts as the given months are of a year.

EXAMPLES.

Ex. 1st. What is the interest of 539*l.* for four months, at 5*l.* per Cent. per Annum?

$$\begin{array}{r}
 \text{£} \\
 539 \\
 .05 \\
 \hline
 26.95 \text{ Interest for a year.} \\
 \text{Months.} \quad \hline
 4 \frac{1}{3} \quad 8.9833 \quad \left. \begin{array}{l} \text{or} \\ 8 \text{ l. } 19 \text{ s. } 8 \text{ d.} \end{array} \right\} \text{facis.}
 \end{array}$$

Ex. 2^d. What will the interest of 729*l.* 10*s.* 6*d.* come to in a year and 5 months, at 6 per Cent. per Annum?

Note. If there are any odd shillings, pence, and farthings, in the principal sum, they must be reduced to decimals; as in this example.

$$\begin{array}{r}
 729.525 \\
 .06 \\
 \hline
 \text{Months } 43.77150 \text{ Interest for a year.} \\
 4 \frac{1}{3} \quad 14.59050 \text{ Interest for 4 months.} \\
 1 \frac{1}{3} \quad 3.647625 \text{ Interest for 1 month.} \\
 \hline
 \text{facis } 62.009625 \text{ Total Interest.} \\
 \text{or} \\
 62 \text{ l. } 0 \text{ s. } 2 \text{ d. } \frac{1}{3}.
 \end{array}$$

4th. But if it be required to find the interest of a sum of money for any number of days, you must either multiply the year's amount by the number of days proposed, and divide the product by 365, or (which will be sometimes shorter) divide the year's amount by 365, and

and multiply the quotient by the number of days proposed.

EXAMPLE.

What interest will 563 l. amount to in 126 days, at 6 l. per Cent. per Annum?

$ \begin{array}{r} 563 \\ .06 \\ \hline 33,78 \\ 126 \\ \hline 20268 \\ 6756 \\ 3378 \\ \hline 365)4256,28(11,661 \\ \hline .606 \\ \hline 2412 \\ \hline 2218 \\ \hline .380 \\ \hline .15 \end{array} $	$ \begin{array}{r} 365)33,78000(.09254 \\ \hline .930 \\ \hline 2000 \\ \hline 1750 \\ \hline 290 \\ .09254 \\ 126 \\ \hline 55524 \\ 18508 \\ 9254 \\ \hline 11,66004 \end{array} $
---	--

But for the more ready casting up the interest of money for days, it will be necessary to have the interest of 1 l. for 1 day, at all rates ready calculated, as a table or standard. Thus:

The INTEREST of 1 l. for 1 Day.

At	1	per Cent. is	,00002739726
	2		,00005479452
	3		,00008219178
	4		,00010958904
	5		,00013698630
	6		,00016438356
	7		,00019178082
	8		,00021917808
	9		,00024657534
	10		,00027397260

The interest of 1 l. for one day, is thus found; the given rate or interest of 100 l. for a year, being divided by 100, quotes the interest of 1 l. for a year; which again divided by 365, gives the required interest of 1 l. for 1 day; which, when multiply'd into both the number of days, and the principal sum, produces the interest for the time required.

E X A M P L E.

What's the interest of 560 l. for 60 days, at 5 l. per Cent. per Annum?

$$\begin{array}{r}
 .0001369863 \\
 \text{560 Principal.} \\
 \hline
 82191780 \\
 6849315 \\
 \hline
 767123280 \\
 \text{60 Days.} \\
 \hline
 \text{Facit 4,6027396800 or 4 l. 12 s. 0 d. } \frac{1}{2}.
 \end{array}$$

The

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ich
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Shewing the Number of Days from any day in any Month to the same day in any other Month.

From	Jan:	Feb:	Mar:	April:	May:	June:
	Feb: 31	Mar: 28	April: 30	May: 30	June: 31	July: 30
	Mar: 29	April: 29	May: 31	June: 31	July: 31	Aug: 31
	April: 30	May: 31	June: 30	July: 31	Aug: 31	Sep: 30
	May: 31	June: 30	July: 31	Aug: 31	Sep: 30	Oct: 31
	June: 30	July: 31	Aug: 31	Sep: 30	Oct: 31	Nov: 30
	July: 31	Aug: 31	Sep: 30	Oct: 31	Nov: 30	Dec: 31
	Aug: 31	Sep: 30	Oct: 31	Nov: 30	Dec: 31	Jan: 31
	Sep: 30	Oct: 31	Nov: 30	Dec: 31	Jan: 31	Feb: 28
	Oct: 31	Nov: 30	Dec: 31	Jan: 31	Feb: 28	Mar: 27
	Nov: 30	Dec: 31	Jan: 31	Feb: 28	Mar: 27	April: 30
	Dec: 31	Jan: 31	Feb: 28	Mar: 27	April: 30	May: 31
	Jan: 31	Feb: 28	Mar: 27	April: 30	May: 31	June: 30

From	July:	Aug:	Sep:	Oct:	Nov:	Dec:
	Aug: 31	Sep: 30	Oct: 31	Nov: 30	Dec: 31	Jan: 31
	Sep: 30	Oct: 31	Nov: 30	Dec: 31	Jan: 31	Feb: 28
	Oct: 31	Nov: 30	Dec: 31	Jan: 31	Feb: 28	Mar: 27
	Nov: 30	Dec: 31	Jan: 31	Feb: 28	Mar: 27	April: 30
	Dec: 31	Jan: 31	Feb: 28	Mar: 27	April: 30	May: 31
	Jan: 31	Feb: 28	Mar: 27	April: 30	May: 31	June: 30
	Feb: 28	Mar: 27	April: 30	May: 31	June: 30	July: 31
	Mar: 27	April: 30	May: 31	June: 30	July: 31	Aug: 31
	April: 30	May: 31	June: 30	July: 31	Aug: 31	Sep: 30
	May: 31	June: 30	July: 31	Aug: 31	Sep: 30	Oct: 31
	June: 30	July: 31	Aug: 31	Sep: 30	Oct: 31	Nov: 30
	July: 31	Aug: 31	Sep: 30	Oct: 31	Nov: 30	Dec: 31

The year being divided into 12 unequal months, the following verses may serve as a memorandum of the number of days in each, viz.

*Thirty days hath September,
April, June, and November;
February hath twenty-eight alone,
And all the rest have thirty-one.*

But without any farther trouble, the opposite table shews, by inspection only, the number of days from any day in any month, to the same day in any other month. As suppose the number of days, betwixt the 4th of February and the 4th of September, were requir'd; looking in the column under February for September, against that month will stand 212; the number of days betwixt the said times: So again, from the 8th of June to the 8th of October, appears by the table to be 122 days, that being the number against October, in the column under June.

Note, If the given days are different, 'tis only adding, or subtracting their inequality to, or from the tabular number. Thus had the first example been from the 4th of February to the 8th of September, it had been 4 days more than 212, viz. 216; or had the time, in the last example, been from the 8th of June to the 4th of October, it had been 4 days less than 122, viz. 118.

Note also, If the time exceeds a year, 365 days must be added. Thus from the 4th of February 1734, to the 4th of September 1735, will be found to be 577 days, the sum of 212, and 365. See the Table.

COMPOUND INTEREST.

1st. TO find the amount of any sum, at any rate of compound Interest, for any number of years.

RULE.

Multiply the amount of 1 *l.* for a year, (which at 6 *per Cent.* is 1.06, at 5 *per Cent.* 1.05, &c.) so often into itself, as are the number of years proposed, wanting one; and the last product multiply'd by the principal, will give the amount required.

EXAMPLE.

What's the amount of 500 *l.* forborn four years, at 4 *l. per Cent. per Annum?*

$$\begin{array}{r}
 1.04 \\
 1.04 \\
 \hline
 1.0816 \\
 1.04 \\
 \hline
 1.124864 \\
 1.04 \\
 \hline
 1.16985856 \\
 500 \\
 \hline
 \text{facit } 584.91928000
 \end{array}$$

And thus is the first interest-table (which shews the amount of 1 *l.* for any number of years, under 33, at the rates of 5 and 6 *per Cent. per Ann.*) form'd.

The use of which is plain and easy; for multiplying the figures standing against the number of years required, and under the given rate, by the proposed principal, the product is the amount desired.

Thus,

Thus, if the amount of 40*l.* in 20 years, at 5*l.* per Cent. per Annum, were required, 2,65329, the tabular number, multiply'd by 40*l.* the principal sum, gives 106, 13160, or 106*l.* 2*s.* 7*d.* $\frac{1}{2}$, the Answer. And so any other.

2d. To find the amount of any annuity, or yearly pension, forborn any number of years whatsoever, at any rate of compound interest.

R U L E.

Multiply the first yearly payment by the amount of 1*l.* for 1 year, and to the product add the second yearly payment, the sum is the amount in 2 years; which, multiply'd again by the said amount, the product, with the addition of the third yearly payment, is the amount for 3 years, &c.

E X A M P L E.

What will a pension of 30*l.* per Annum amount to, being forborn 4 years, at 5*l.* per Cent. per Annum?

	1	
First yearly payment	30	
multiply'd by	1,05	
	31,50	
Second yearly payment added	30	
	61,50	the amount in 2 years.
	1,05	
	64,5750	
Third yearly payment	30	
	94,5750	amount in 3 years.
	1,05	
	99,303750	
Fourth yearly paym.	30	
	129,303750	amount in 4 years.
		And

And after this manner, is the second interest table (which shews the amount of 1 l. annuity for any number of years under 33, at the rates of 5 and 6 l. per Cent. per Ann. compound Interest) compos'd.

But this second table may more easily be form'd from the first, thus: the first line of this second table, or first year's amount being known, add to it the first line of the first table, the sum is the amount of 2 years, or the second line of this table; to which again adding the second line of the first table, you have the third of this, or the amount for three years, &c.

EXAMPLE, at 6 l. per Cent.

1.	
1,	———— First year of the second table.
1,06	———— First of the first table.
2,06	———— Second year of the second table.
1,1236	———— Second year of the first.
3,1836	———— Third year of the second.
1,19101	———— Third year of the first.
4,37461	———— Fourth year of the second, &c.

The use of this second table is in the same manner as the first; as suppose the foregoing question for an example.

EXAMPLE.

$$4,31012 \left\{ \begin{array}{l} \text{the amount of 1 l. annuity for} \\ \text{4 years, at 5 l. per Cent.} \end{array} \right.$$
 multiply'd by 30 the yearly sum,

gives 129,30360 as before.

REBATE, or DISCOMPT.

REBATE, according to simple interest, having been sufficiently explained in *Vulgar Arithmetic*, I shall only here set down one example work'd decimally the common way. And to complete the section, add Mr. Hutton's new method of finding the present worth and discompt of money, as delivered in his *System of Arithmetic*, pag. 188.

EXAMPLE.

What discompt must be allowed on a bill of 500 l. paid 20 days before it is due, rebate at 5 l. per Cent. per Annum? And what present money must be paid?

The common way.

Days.	l.	Days.
If 365	— 5 —	20
		5
		365)1000(27397
		2700
		1450
		3550
		2650
		95

Then

[198]

Then for the discount:

$$\text{If } 100,27397 \text{ --- } 100 \text{ --- } 100$$

$$100,27397) 136,98500 (1,3661 \text{ discount.}$$

$$36711030$$

$$66288390$$

$$61240080$$

$$10756980$$

$$629593$$

Or for the present worth:

$$\text{If } 100,27397 \text{ --- } 100 \text{ --- } 100$$

$$100,27397) 50000,000 (498,6338 \text{ present worth.}$$

$$98904120$$

$$86575470$$

$$63562940$$

$$33985180$$

$$39031890$$

$$89516990$$

$$9297814$$

Mr. HATTON's New Method.

1. For the present worth, multiply the days in a year, the principal given, and 100 into each other, for a dividend; and add the product of 365 by 100, to that of the days multiply'd into the rate given for the divisor; so the quotient arising is the answer.

Thus

Thus in the foregoing example, $365 \times 500 \times 100 = 18250000$ for the dividend, and $365 \times 100 \div 10 \times 5 = 36600$ for the divisor.

See the work.

$366 \overline{) 182500 \mid 00} (498,6338 \text{ present worth.}$

$$\begin{array}{r}
 3610 \\
 \hline
 3160 \\
 \hline
 2320 \\
 \hline
 1240 \\
 \hline
 1420 \\
 \hline
 322
 \end{array}$$

2. For the discount, multiply the rate principal, and days given together for a dividend; and proceeding as before directed for a divisor, the quotient will be the answer.

Thus keeping still the same example, $5 \times 500 \times 10 = 50000$ for the dividend, and $365 \times 100 \div 10 \times 5 = 36600$ for a divisor, as before.

See the work.

$366 \overline{) 500 \mid 00} (1,3661 \text{ discount.}$

$$\begin{array}{r}
 1340 \\
 \hline
 2240 \\
 \hline
 2240 \\
 \hline
 440 \\
 \hline
 74
 \end{array}$$

The

The truth of both these methods appears, not only by their agreement, but also by the addition of the present worth, and discount, found; which, as near as can be, makes the principal.

Thus 498,6338 the present worth,
with 1,3661 the discount,

makes 499,9999 = 500 l. the given principal.

REBATE at COMPOUND INTEREST.

1st. TO find the present worth of any sum to be paid at any number of years to come, rebate being made at any rate of compound interest.

R U L E.

Divide the principal continually so many times by the amount of 1 l. for 1 year, as are the number of years proposed, and the last quotient is the answer.

E X A M P L E.

What is the present worth of 1 l. to be paid at the end of 6 years, rebate at 6 l. per Cent. per Ann. compound interest?

l.		Years.	
The principal 1,			
.943396	divi-	.943396	present
.889997	ded by	.889997	worth
.839619	1.06	.839619	at the
.792094	gives	.792094	end of
.747258		.747258	
		.704960	

And thus is the third table made, which shews the present worth of 1 l. due at any number of years to come, under 33. rebate at 5 and 6 l. per Cent. per Ann. compound interest; the use of which is as the

the other tables, only by multiplying the present worth of 1 *l.* by the given principal, and the product is the present worth required.

Thus, suppose in the example above, the principal had been 200 *l.* the present worth of 1 *l.* viz. .704960 multiply'd by 200, gives 140,992000, the present worth of 200 *l.* and so any other.

2d. To find the present worth of any annuity, or yearly pension, to continue any number of years; rebate being made at any rate, *per Cent. per Annum*, compound interest.

R U L E.

Find by the foregoing rule the present worth of the propos'd annuity, for 1, 2, 3, or so many years as are demanded; and the sum of those respective present worths will be the value of the annuity; that is, the first and second of those values, added together, will be the present worth for two years; and the first, second, and third, added for three years, &c.

E X A M P L E.

What's the present worth of an annuity of 50 *l.* to continue four years, rebate at 5 *l. per Cent. per Annum*?

$$\begin{array}{l}
 \text{1.} \\
 50, \\
 47,61904 \\
 45,35147 \\
 43,19187
 \end{array}
 \left. \vphantom{\begin{array}{l} 50, \\ 47,61904 \\ 45,35147 \\ 43,19187 \end{array}} \right\} \begin{array}{l} \\ \text{divided by } 1,05 \\ \text{gives} \end{array}
 \left\{ \begin{array}{l} 47,61904 \\ 45,35147 \\ 43,19187 \\ 41,13512
 \end{array} \right.$$

The total of which is 177,29750 the present
(worth requir'd)

And after this manner is made table the fourth, which shews the present worth of 1 *l.* annuity, to continue any number of years under 33, rebate at 5
and

and 6 l. per Cent. per Ann. compound interest. Which table, as the others, will give the present worth of any sum whatsoever, by only multiplying the value of 1 l. by the sum proposed. Thus, suppose the foregoing example.

EXAMPLE.

multiply'd by $\begin{array}{r} 3,54595 \text{ the present worth of 1 l. an. for 4 years.} \\ 50 \text{ the annuity proposed,} \end{array}$

gives $177,29750$ as before.

The fourth table may be also form'd from the third, thus:

The first year is the same in both; the first and second years of the third, added together, make the second of the fourth; the second year of the fourth, added to the third year of the third, makes the third of the fourth table, &c. See the example.

EXAMPLE, at 6 l. per Cent.

.94339* The first year of both tables.

.88999 The second year of the third table.

1,83339 The second year of the fourth.

.83961 The third year of the third.

2,67300 The third year of the fourth.

&c.

* Note, 1 is added to the right hand figure, in consideration of the places omitted.

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8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

Decimal Tables,

Shewing

TABLE 1. The Amount of 1 £ for any number of Years from 1 to 25 at the Rate of 3547 per Cent. Ann. Simple Interest. TABLE 2. The Amount of 1 £ for any number of Years from 1 to 25 at the Rate of 3547 per Cent. Ann. Simple Interest.

3		4		3	4
1.03000	1.04000	1	1.00000	1.00000	
1.06090	1.08160	2	2.03000	2.04000	
1.09273	1.12480	3	3.06090	3.12160	
1.12551	1.16960	4	4.10273	4.24800	
1.15925	1.21600	5	5.15551	5.41920	
1.19397	1.26400	6	6.21925	6.63520	
1.22967	1.31360	7	7.29397	7.89600	
1.26637	1.36480	8	8.37967	9.20160	
1.30407	1.41760	9	9.47637	10.55200	
1.34277	1.47200	10	10.58407	12.04800	
1.38247	1.52800	11	11.70277	13.69000	
1.42317	1.58560	12	12.83247	15.47800	
1.46487	1.64480	13	13.97317	17.41200	
1.50757	1.70560	14	15.12487	19.50200	
1.55127	1.76800	15	16.28857	21.74800	
1.59597	1.83200	16	17.46427	24.15000	
1.64167	1.89760	17	18.65197	26.70800	
1.68837	1.96480	18	19.85167	29.42200	
1.73607	2.03360	19	21.06337	32.29200	
1.78477	2.10400	20	22.28707	35.31800	
1.83447	2.17600	21	23.53277	38.50000	
1.88517	2.24960	22	24.79047	41.83800	
1.93687	2.32480	23	26.06017	45.33200	
1.98957	2.40160	24	27.34187	48.98200	
2.04327	2.48000	25	28.63557	52.78800	
2.09797	2.56000	26	29.94127	56.75000	
2.15367	2.64160	27	31.25897	60.86800	
2.21037	2.72480	28	32.58867	65.14200	
2.26807	2.80960	29	33.93037	69.57200	
2.32677	2.89600	30	35.28407	74.15800	
2.38647	2.98400	31	36.64977	78.90000	
2.44717	3.07360	32	38.02747	83.79800	

Decimal Tables,

Shewing

TABLE 3. The present Value of 1 £ due at any Time. Table 4. The present Value of 1 £ annuity for any Years under 50 Years. Table 5. The present Value of 1 £ annuity for any Years under 50 Years. Table 6. The present Value of 1 £ annuity for any Years under 50 Years.

3	4	5	3	4
970874	.961538	1	0.97087	0.96154
942596	.924256	2	1.91247	1.88609
915142	.88996	3	2.82861	2.77609
88847	.85804	4	3.71710	3.62969
86269	.82827	5	4.57971	4.4582
83744	.79994	6	5.41712	5.26014
81309	.77318	7	6.22988	6.04006
78949	.74790	8	7.01909	6.79274
766416	.72387	9	7.78611	7.42820
744094	.69984	10	8.53020	8.11000
722421	.676381	11	9.25262	8.75048
701380	.653497	12	9.95400	9.35007
680951	.630574	13	10.63496	9.90965
661118	.577475	14	11.29607	10.5012
641862	.550264	15	11.93793	11.1029
623167	.533900	16	12.56110	11.6980
605016	.513373	17	13.16612	12.16567
587394	.493629	18	13.75281	12.60930
570286	.474642	19	14.32200	13.13294
553676	.456387	20	14.87747	13.62932
537550	.438833	21	15.41302	14.09916
521892	.421955	22	15.92992	14.45112
506692	.405726	23	16.44261	14.85624
491934	.390121	24	16.93994	15.24696
477606	.375117	25	17.41315	15.62208
463695	.360689	26	17.87624	15.98277
450189	.346817	27	18.32703	16.32959
437077	.333477	28	18.76411	16.66306
424346	.320651	29	19.18845	16.98371
411987	.308319	30	19.60044	17.29203
399987	.296460	31	20.00045	17.58849
388337	.285058	32	20.38877	17.87366

Journal of the

Date		Place		Remarks	
1862	Jan 1	Wilmington	Del.	Left for New York	
1862	Jan 2	New York	N.Y.	Arrived at New York	
1862	Jan 3	New York	N.Y.	Left for Philadelphia	
1862	Jan 4	Philadelphia	Pa.	Arrived at Philadelphia	
1862	Jan 5	Philadelphia	Pa.	Left for Washington	
1862	Jan 6	Washington	D.C.	Arrived at Washington	
1862	Jan 7	Washington	D.C.	Left for Richmond	
1862	Jan 8	Richmond	Va.	Arrived at Richmond	
1862	Jan 9	Richmond	Va.	Left for Norfolk	
1862	Jan 10	Norfolk	Va.	Arrived at Norfolk	
1862	Jan 11	Norfolk	Va.	Left for New York	
1862	Jan 12	New York	N.Y.	Arrived at New York	
1862	Jan 13	New York	N.Y.	Left for Philadelphia	
1862	Jan 14	Philadelphia	Pa.	Arrived at Philadelphia	
1862	Jan 15	Philadelphia	Pa.	Left for Washington	
1862	Jan 16	Washington	D.C.	Arrived at Washington	
1862	Jan 17	Washington	D.C.	Left for Richmond	
1862	Jan 18	Richmond	Va.	Arrived at Richmond	
1862	Jan 19	Richmond	Va.	Left for Norfolk	
1862	Jan 20	Norfolk	Va.	Arrived at Norfolk	
1862	Jan 21	Norfolk	Va.	Left for New York	
1862	Jan 22	New York	N.Y.	Arrived at New York	
1862	Jan 23	New York	N.Y.	Left for Philadelphia	
1862	Jan 24	Philadelphia	Pa.	Arrived at Philadelphia	
1862	Jan 25	Philadelphia	Pa.	Left for Washington	
1862	Jan 26	Washington	D.C.	Arrived at Washington	
1862	Jan 27	Washington	D.C.	Left for Richmond	
1862	Jan 28	Richmond	Va.	Arrived at Richmond	
1862	Jan 29	Richmond	Va.	Left for Norfolk	
1862	Jan 30	Norfolk	Va.	Arrived at Norfolk	
1862	Jan 31	Norfolk	Va.	Left for New York	
1862	Feb 1	New York	N.Y.	Arrived at New York	

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Chapter LXI	The History of the	600
Chapter LXII	The History of the	610
Chapter LXIII	The History of the	620
Chapter LXIV	The History of the	630
Chapter LXV	The History of the	640
Chapter LXVI	The History of the	650
Chapter LXVII	The History of the	660
Chapter LXVIII	The History of the	670
Chapter LXIX	The History of the	680
Chapter LXX	The History of the	690
Chapter LXXI	The History of the	700
Chapter LXXII	The History of the	710
Chapter LXXIII	The History of the	720
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Chapter LXXXXII	The History of the	910
Chapter LXXXXIII	The History of the	920
Chapter LXXXXIV	The History of the	930
Chapter LXXXXV	The History of the	940
Chapter LXXXXVI	The History of the	950
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Decimal Tables

Showing

TABLE 1. The Amount of
one Pound for any Number
of Years under 22 at full Rate
of 546 per Cent. Com. Inter.

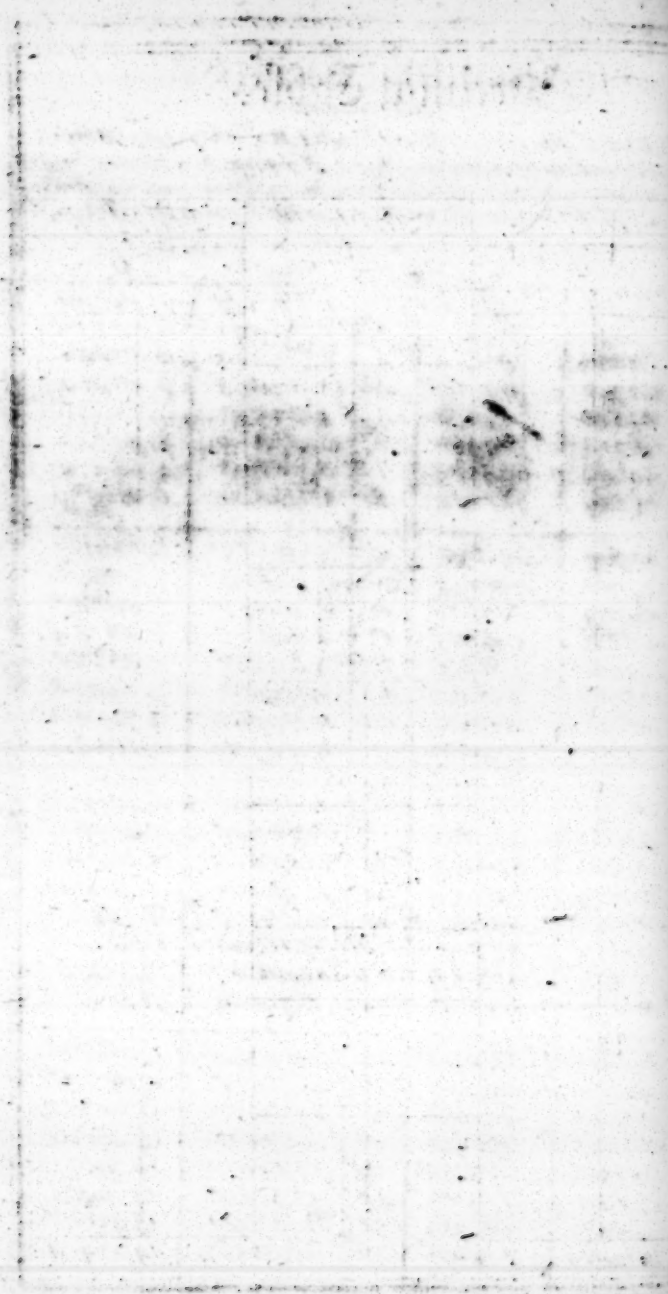
TABLE 2. The Amount of
one Pound for any Number
of Years under 22 at full Rate
of 546 per Cent. Com. Inter.

5	6	7	5	6	7
1.05000	1.06000	1	1.00000	1.00000	1.00000
1.10250	1.12360	2	2.06000	2.06000	2.06000
1.15762	1.19101	3	3.16280	3.16280	3.16280
1.21530	1.26247	4	4.31012	4.31012	4.31012
1.27558	1.33822	5	5.52163	5.52163	5.52163
1.33849	1.41872	6	6.80198	6.80198	6.80198
1.40410	1.50453	7	8.14300	8.14300	8.14300
1.47245	1.59584	8	9.54910	9.54910	9.54910
1.54332	1.69298	9	11.02666	11.02666	11.02666
1.61689	1.79624	10	12.67789	12.67789	12.67789
1.71034	1.89589	11	14.50678	14.50678	14.50678
1.79586	2.01219	12	16.51712	16.51712	16.51712
1.88366	2.13232	13	17.71298	17.71298	17.71298
1.97393	2.26690	14	19.10663	19.10663	19.10663
2.07592	2.29686	15	21.67806	21.67806	21.67806
2.18287	2.34088	16	23.60749	23.60749	23.60749
2.29201	2.69277	17	25.84026	25.84026	25.84026
2.40662	2.86424	18	28.13228	28.13228	28.13228
2.52696	3.02849	19	30.48900	30.48900	30.48900
2.65329	3.20712	20	32.91296	32.91296	32.91296
2.78596	3.39926	21	35.71926	35.71926	35.71926
2.92536	3.60363	22	38.80521	38.80521	38.80521
3.07152	3.81998	23	41.43047	41.43047	41.43047
3.22510	4.04898	24	44.60929	44.60929	44.60929
3.38628	4.29087	25	47.72709	47.72709	47.72709
3.55607	4.54598	26	51.11240	51.11240	51.11240
3.72245	4.81224	27	54.66972	54.66972	54.66972
3.90013	5.11168	28	58.40288	58.40288	58.40288
4.11013	5.44488	29	62.32271	62.32271	62.32271
4.24194	5.74249	30	66.43884	66.43884	66.43884
4.42389	6.06910	31	70.76779	70.76779	70.76779
4.76491	6.42388	32	75.29983	75.29983	75.29983

Annual Tables

TABLE 3 The present worth of 1000 £. The present worth of 1 £ due at any number of years, according to various rates of interest, under 22. The number of years under 100. The rate of interest from 2 to 10 per cent. The number of years from 100 to 200. The rate of interest from 10 to 20 per cent.

5	6	7	8	9
952381	942396	1	9.98238	9.94239
907030	897045	2	1.85941	1.83313
863838	853853	3	2.71324	2.67301
822702	812717	4	3.54698	3.46510
783528	773543	5	4.35997	4.21236
746285	736299	6	5.15269	4.91732
710962	700977	7	5.92567	5.62238
677539	667554	8	6.67931	6.29719
646069	636084	9	7.41782	6.94169
616593	606608	10	7.72173	7.36008
589079	579094	11	8.20641	7.80007
563537	553552	12	8.68225	8.23884
539931	529946	13	9.14967	8.65268
518208	508223	14	9.60909	9.04498
498317	488332	15	10.06098	9.71275
480111	470126	16	10.50577	10.10289
463696	453711	17	10.94406	10.47726
449020	439035	18	11.37648	10.83760
436074	426089	19	11.80332	11.18811
424809	414824	20	12.22511	11.53092
415142	405157	21	12.64216	11.76407
407049	397064	22	13.05500	12.04158
400571	390586	23	13.46407	12.30338
395667	385682	24	13.86969	12.55035
392302	382317	25	14.27234	12.78335
389440	379455	26	14.67218	13.00316
387046	377061	27	15.06903	13.21053
385093	375108	28	15.46302	13.40616
383546	373561	29	15.85407	13.59072
382377	372392	30	16.24245	13.76483
381469	371484	31	16.62851	13.92908
380782	370797	32	17.01267	14.08404



More **EXAMPLES** for the Exercise of the foregoing
RULES and TABLES.

Ex. 1st. What will 1000 *l.* increase to, forborn 22 years, at 5 *per Cent. per Annum* compound interest?

Answer, 2925 *l.* 5 *s.* 2 *d.* $\frac{1}{2}$.

Ex. 2^d. What would an annuity of 520 *l.* forborn 17 years, at 6 *per Cent.* compound interest, amount to?

Answer, 14670 *l.* 13 *s.* 11 *d.* $\frac{1}{2}$.

Ex. 3^d. What present money would discharge a debt of 7500 *l.* to be paid at the end of 10 years, rebate being made at 5 *l. per Cent. per Annum*?

Answer, 4604 *l.* 6 *s.* 11 *d.* $\frac{1}{2}$.

Ex. 4th. What is the yearly rent of 65 *l.* to continue 30 years, worth in ready money, rebate being made at 6 *per Cent. per Annum* compound interest?

Answer, 894 *l.* 14 *s.* 3 *d.* $\frac{1}{2}$.

Ex. 5th. What is the present worth of a reversion of a lease of 500 *l. per Annum*, to continue 20 years, but not to commence till after the end of five years, allowing the purchaser 6 *per Cent.* compound interest?

Note, To work questions of this nature, there must be two distinct operations, *viz.*

1st. The present worth of the proposed annuity; for the given time of its continuance must be found as if it were immediately to commence. Then,

2^d. See what principal, forborn at the given interest, would, in the time of the reversion, amount to the aforesaid present worth, and that principal will be the present worth of such annuity in reversion.

Thus

Thus, by table the 4th, the present worth of 1 l. per Annum, to continue 20 years, at 6 l. per Cent. is found to be -

<i>which multiply'd by the proposed annuity</i>	11,46992
	500
	gives 5734,9600

Then in the first table, against 5 years, the time of the reversion, under the same rate of interest, is found 1,33822, the amount of 1 l. in the said time; therefore,

If 1,33822 arise from 1 l. from what principal does 5734,96000 arise?

Answer, 4285,5135, or 4285 l. 10 s. 3 d. $\frac{1}{2}$.

Or it may more easily be done by first finding the present worth of the annuity for the whole time, both of possession and reversion, and then deducting the present worth of the possession; the remainder will be the present worth of the reversion. Thus 12,78335, the tabular number, against 25 years, the whole time being multiply'd by 500, gives 6391,67500; from which subtracting 2106,18000, the produce of 4,21236; the tabular number against 5 years, the time of the possession, the remainder 4285,49500, is the value of the reversion: Within a trifle the same answer as before.

FREEHOLD ESTATES.

TO find the present worth of any annual rent, to continue for ever, commonly called fee-simple.

R U L E

R U L E.

Divide the proposed rent by the interest of 1 *l.* for one year, (which at 5 *l.* per Cent. is .05, or at 6 per Cent. .06, as before shewn) and the quotient is the present value of the estate.

E X A M P L E.

What is an estate of 200 *l.* per Annum, to continue for ever, worth in ready money, allowing the purchaser 5 *l.* per Cent. per Annum, compound interest?

$$\begin{array}{r} \text{---.05)200.00} \\ \text{Answer, 4000.} \end{array}$$

Or it may be done by multiplying the fee-simple of 1 *l.* by the yearly rent proposed.

The fee-simple of 1 *l.* per Annum compound interest, at

1 per Cent.	2 per Cent.	3 per Cent.	4 per Cent.	5 per Cent.
100,00000	50,0000	33,33333	25,00000	20,00000

6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
16,66667*	14,28571	12,50000	11,11111	10,00000

* Note, In contracting a line of decimals from many to fewer places, 1 is added to the last figure retained, if the next omitted figure exceedeth 5; which rule hath been all along observed in the tables, &c.

The foregoing question work'd by the last rule.

The fee-simple of 1 <i>l.</i> per Ann. at 5 <i>l.</i> per Cent. is	20
which multiply'd by the yearly rent,	200
gives as before,	4000

I will now only add another example or two, for the reader's exercise, and conclude this rule.

1. *A* has the possession of an estate of 120 *l.* per Annum, to continue 20 years; *B.* has the reversion of the same, from that time for ever. What must *A.* give *B.* if he would purchase his reversion? And what must *B.* give *A.* if he would buy his possession, accounting 6 per Cent. compound interest in each case?

	<i>A.</i>	<i>B.</i>
<i>Answer,</i> { <i>A's</i> possession is worth	149	19d
{ <i>B's</i> reversion is worth	675	11 6d

2. *A.* agrees with *B.* for the annuity of 600 *l.* per Annum, to continue 25 years, to give him the present worth of it, at 6 *l.* per Cent. per Annum; but not having money enough by him, offers to make over to him a freehold estate of 12 *l.* per Annum, at the same interest: What money besides will pay his purchase?

Answer, 7470 *l.* or 2 d.



BOOKS

CHAP. XI.

Of FELLOWSHIP.

Without taking any notice of the common way of working this rule, observe this much more compendious method.

RULE.

Divide the whole gain, or loss, by the whole stock; and multiply the quotient by each man's particular stock; the several products are the respective gains of each.

Note. It is necessary to place so many cyphers on the right hand of your dividend, as will bring out six or seven places of decimals in the quotient.

EXAMPLE.

Suppose *A.*, *B.* and *C.* trading together, *A.* puts in 500*l.*, *B.* 700*l.* and *C.* 1200*l.* the whole gain is 836*l.* What share of it belongs to each?

	l.
A.	500
B.	700
C.	3200
Total paid	4400

11600

20000

20000

20000

20000

20000

348333

500

348333

700

348333

3200

A's share	174,166,500	B's share	243,833,100	C's share	417,999,600
B's share	243,833,100				
C's share	417,999,600				

The gain 835,999,200, or 836l. as near as can be.

See another EXAMPLE with Time.

A. puts into company 525 l. 10s. for six months, B. 382 l. 15s. for eight months, and C. 1000 l. for four months; they gain in all 1286 l. 12s. How much is that for each?

	525.8 6	382.75 8	1800 4
A's amt	3153.0	3062.00	4000
B's amt	3062		
C's amt	4000		

10215)1286,60000(,125952

	,125952 3153	,125952 3062	,125952 4000
A's amt	397,126656	385,665024	503,800000
B's amt	385,665024		
C's amt	503,800000		

Total, 1286,595080, or 128661. 12 A. 128661. 12



CHAP. VII.

Of EVOLUTION, OR EXTRACTION of
ROOTS.

The SQUARE ROOT.

Extraction of the Square Root is finding the side of a square figure; or, numerically speaking, it is finding what number, multiply'd by itself, will produce the number given. Thus the square root of 16 is 4, 4 times 4 making 16.

What a square is, may be seen in the following figure; which being divided every way into 3 equal parts, its whole content or square is 9, and its side or root is 3.



Square numbers are either single or compound.

A single square number is always less than 100, being produced by the multiplication of some one single figure by itself; as 16 from 4. &c. So that the root of any single square may be found in the annexed table, always taking the root of the next less square, for any number not there inserted; as, for 26 take 5, or 3 for 10, &c.

Square	1	4	9	16	25	36	49	64	81
Roots	1	2	3	4	5	6	7	8	9

A compound square number being compos'd by the multiplication of two or more figures by themselves, always exceeds 100; as 144, which is 12 times 12; or 196, which is 14 times 14, &c.

If the root therefore is express'd by two figures, its square must at least consist of three; for the least root express'd by two figures is 10, whose square is 100. And if the root has three figures, its square must at least have five. If four, the square has seven, &c. So that you cannot augment the root one figure, but you increase the square two.

To find the Root of any compound square Number; as suppose 2704.

1st You must distinguish it into single squares, by placing dots over every other figure, beginning at the right hand, thus;

2704

And so many dots as happen, so many places will the root consist of; which in this example are two.

K 4

2dy.

2^{dly}. Drawing a crooked line on the right hand of your number, as in division, find the root of your first single square, and place it in the quotient.

See the work.

$$\begin{array}{r} 2704 \end{array}$$

3^{dly}. Placing the square of the root found, under the first single square, subtract, and set down the remainder; bringing down to it the next single square, call the line a *Resolvend*.

$$\begin{array}{r} 2704 \\ 25 \\ \hline \end{array}$$

• 204 *Resolvend*.

4^{thly}. Drawing another crooked line on the left hand of the said resolvend, place beyond it the double of the quotient, in form of a divisor.

$$\begin{array}{r} 2704 \\ 25 \\ \hline 10 \end{array}$$

5^{thly}. Dividing the resolvend, all but the unit's place, by the said divisor, (which, in this example, is the 10's in 20) set down the number of times it goes, (viz. 2) both in the quotient, and on the right hand of the divisor.

$$\begin{array}{r} 2704 \\ 25 \\ \hline 102 \end{array}$$

102) 204 *Resolvend*.

6^{thly}.

6thly. Multiplying the whole divisor by the figure last placed in the quotient, set down the product under, and subtract it from the resolvend.

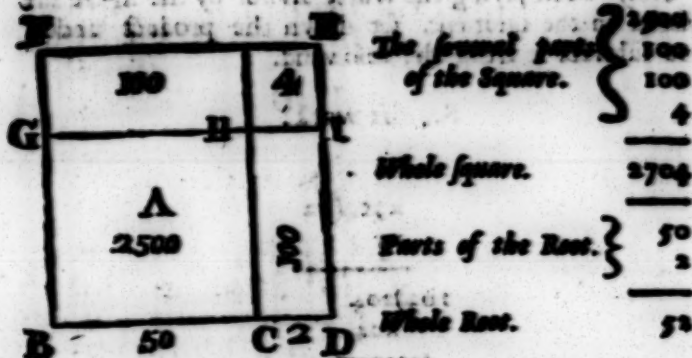
See the work:

$$\begin{array}{r}
 2704 \overline{) 58} \\
 25 \\
 \hline
 100 204 \\
 204 \\
 \hline
 0
 \end{array}$$

Note, If the divisor, multiply'd by the quotient-figure, gives a product greater than the resolvend, 'tis false, and must be rectified by a smaller quotient-figure.

Extraction of the square root being a matter rather literal than numeral, the reason of the rules above given for its operation, will best appear from the following figure: Wherein let it be considered, that if the root B.C. of the figure A, be augmented by the magnitude C.D. the said square will be enlarged by the figure C.D. E.F.G.H.I. equal to an oblong or long square, whose length shall be the root B.C. twice taken, with the line C.D. and breadth the same line C.D.

N.B. The particular contents of the several parts of the figure are as therein set down.



In the operation therefore, having taken the nearest root of the first square 27, viz. 5, and placed it in the quotient, from the place it stands in, (viz. the second) it must be accounted 50; the square of which, viz. 2500 (marked A. in the figure) being subtracted from the given number 2704, there remains 204, equal to the figure C. D. E. F. G. H. I. In order to find the content of which, I double the root B. C. viz. 50, for the two sides C. E. and E. G. which making 100, I set it down as a divisor; and to find the height of the said figure, viz. C. D. I seek how often the said divisor is contained in the number 204; and finding it twice, I set down two in the quotient for the said height, and also in the next part of my divisor for the side E. I. Then multiplying the base by the height, I have the content of the whole marked figure C. D. E. F. G. H. I. viz. 204, exactly equal to the number remaining after the subtraction of the first great square 2500; so that the number given, viz. 2704, appears to be a perfect square, whose root or side is exactly 52.

Now, As many single squares as are in the number proposed, so many times must the work of the three last rules be repeated; every square being to be brought down, as directed in the third rule.

EXAMPLE.

[235]

EXAMPLE.

What's the Root of 5821697763 *As before.*

$$\begin{array}{r}
 49 \\
 \hline
 146 \overline{) 921} \text{ Resolvend } \\
 \underline{876} \\
 1523 \overline{) 4569} \text{ Resolvend } \\
 \underline{4569} \\
 \hline
 0
 \end{array}$$

In this example, to 49 the second remainder, 69 the next square, being brought down, makes 4569 for a new resolvend; and 76, the quotient-figure, being doubled for a new divisor, makes 152, which going three times in the resolvend, 3 is plac'd both in the quotient, and on the right hand of the divisor, which being then multiply'd by 3, gives 4569, equal to the resolvend; so that nothing remains.

PROOF.

The proof of this extraction, is only multiplying the root found by itself; which, if right, will produce the square number given. Now, If any thing remains, it must be taken in.

To find the fractional Part of the Root.

Add to the number given a competent number of pairs of cyphers, and proceed by the foregoing rules: As suppose 75896 were given for an example.

K 6

EXAMPLE.

EXAMPLE.

$$\begin{array}{r}
 \dots\dots\dots \\
 75896,000000(275,492 \\
 4 \\
 \hline
 47)358 \\
 329 \\
 \hline
 545)2996 \\
 2725 \\
 \hline
 5504)27100 \\
 22016 \\
 \hline
 55089)508400 \\
 495801 \\
 \hline
 550982)1259900 \\
 1101964 \\
 \hline
 = 157936
 \end{array}$$

Note. As many pairs of cyphers as are added, so many places of decimal parts will there be in the root.

To extract the SQUARE ROOT of a VULGAR FRACTION.

FIND the root of the numerator for a numerator; and let the root of the denominator be its denominator; thus the square root of $\frac{1}{4}$ is $\frac{1}{2}$, and of $\frac{9}{16}$ is $\frac{3}{4}$, &c.

The root of a mix'd number is also found after the same manner, being first reduced into an improper fraction;

fraction; thus $6\frac{1}{2}$, reduced, makes $2\frac{1}{2}$, the root of which is $\frac{5}{2}$, or $2\frac{1}{2}$.

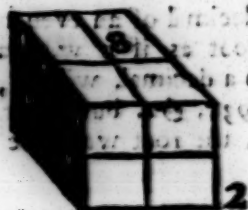
But if either a proper fraction, or a mix'd number, be incommensurable to its root; to extract it, reduce the fraction to a decimal of an even number of places, and extract the root as if it were a whole number: thus $\frac{1}{2}$, reduced to a decimal, will be .5750, the square root of which is .758. &c. but had it been $4\frac{1}{2}$, which reduced is 4.5750, the root would be 2.1394, &c.

The CUBE ROOT.

Extraction of the Cube Root, is finding the side of a solid figure, whose length, breadth, and depth, are equal; or, numerically speaking, it is finding what number, multiply'd twice into itself, will produce the number given; thus the Cube Root of 64 is 4, 4 times 4 being 16, and 4 times 16 make 64.

What a Cube is, may be something explain'd by the following figure; wherein 8 dice are so disposed, that there are 2 every way, that is, 2 in length, 2 in breadth, and 2 in height; so that 8 is the cube, and 2 the root.

See the figure.



Cube-numbers are either single or compound.

A single cube-number is always less than 1000, being produced by the multiplication of one single figure, first by itself, and then by its product; as 125 from 5, &c. So that the root of any single cube may be found in the annexed table; always remembering to take the root of the next less cube for any number not there inserted, as for 512 take 8, or 6 for 220, &c.

Cubes	1	8	27	64	125	216	343	512	729
Squares	1	4	9	16	25	36	49	64	81
Roots	1	2	3	4	5	6	7	8	9

A compound cube-number, being composed by the multiplication of 2 or more figures, first by themselves, and then by their product, always exceeds 1000, as 1728 from 12, or 15625 from 25, &c.

If therefore the root is express'd by two figures, its cube must at least consist of four; for the least root express'd by two figures is 10, whose cube is 1000; if the root has three figures, its cube must at least have seven, &c. So that you cannot augment the root one figure, but you increase the cube three.

Therefore,

Therefore, to find the root of any compound cube-number, as suppose 15625.

1st. You must distinguish it into single cubes, by placing dots over every third figure, beginning from the right hand, thus:

15625

And so many dots as happen, so many places will the root consist of; which, in this example, are two.

2^{dy}. Drawing a crooked line on the right hand of your number, as in division, set down as a quotient the root of your first single cube; which, in this example, is 5.

3^{dy}. Placing 8 the cube of 2, the root found, under 15 the first single cube, subtract, and to the remainder 7 bring down 625, the next single cube, and it will make 7625; which call a Resolvent.

See the work.

15625
8

7625 Resolvent.

4^{thly}. Draw a line under the resolvent, and tripling the square of the root 5, set the said triple figure (viz. 12) under the resolvent; so that units in the said triple square may stand under the place of hundreds in the resolvent.

555.

5thly. Subscribe also the triple of the root 2, (viz. 6) so that units, in this, may stand under the place of tens in the resolvend.

6thly. The triple square of the root, and triple root, being placed as directed, draw a line under them, and add them together in the order they are placed; the sum 126 is a divisor.

7thly. Accounting all the resolvend, except the place of units, (viz. 762) a dividend, seek how often the divisor (126) is contained in it, and place the number of times (which is here 5) in the quotient.

8thly. Draw a line under the divisor, and multiplying the triple square (12) by 5, the figure last placed in the quotient, set the product (60) so under the said triple square, that units may stand under units, and tens under tens.

9thly. Squaring the figure (5) last placed in the quotient, multiply its square (viz. 25) by the triple root (6), and place the product (150) so, that units, in this, may stand under units in the said triple number.

10thly. Subscribe the cube of (5), the figure last placed in the quotient, which will be 125; so that tens, in this, may stand under units in the former product.

11thly. Then drawing a line, add the three numbers last placed together; and subtracting the sum 7625 (which is called the *oblationem*) from the resolvend, set down the remainder (if any) in order underneath, as in common subtraction.

See the work:

17625(25
5 Cube of 2.

7625 Resolvend.

12 Triple Square of 2.
6 Triple of the Root 2.

126 Divisor.

60 Triple Square $\times 5$.
150 Triple Root $\times 5 \times 5$.
125 Cube of 5.

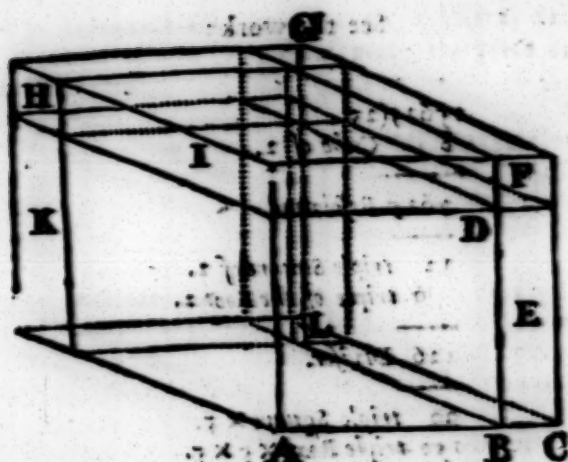
7625 Abolition.

Note. If the given number hath more places, the next single cube must be brought down to the last remainder, for a new resolvend; and the work of the 4th, 5th, 6th, 7th, 8th, 9th, 10th, and 11th rules, must be repeated as often as you so form a new resolvend.

Note also. If the *abolition* is greater than the resolvend, the work is false, and must be rectified by placing a lesser figure in the quotient.

To account for these rules of extracting the cube root, we must again make use of a figure with literal references, as follows:

From



From whence it appears, That if the root AB of the cube AD be augmented by the magnitude BC the cube is thereby enlarged by the addition of seven parallelepipeds, * viz. 1st. The little cube G whose root is the line BC . 2^d. The three parallelepipeds marked I, K, L which have the square of the root AB for base, and the line BC for height. 3^d. The three parallelepipeds marked F, E, L which have the square of the line BC for base, and the root AB for height.

In the operation therefore of the foregoing example, 15625 being divided into single cubes, it appears that the root will consist of two places: The nearest root then of the first cube 15, viz. 2, being placed in the quotient, where its value will be 30, from the place it stands in, and its cube 3000 subtracted from the given number 15625, the remainder 7625 will be equal to the seven parallelepipeds, G, I, K, E, F, H, L the bases of three of which, viz. I, K, L being the

* *Parallelepipedes is a Geometrical Term, signifying regular Figures, whose opposite Sides and Angles are equal.*

square of the root $A.B.$ three times the square of 20 , viz. 1200 is set down under the said remainder, or resolvend; also three more of the said parallelepipeds, viz. $I.K.E.$ having their height equal to the said root, three times 20 , viz. 60 , the sum of the three heights is added to the said 1200 , the sum of the bases of the other three, for a divisor; by which, dividing the resolvend, the number of times it goes, viz. 5 , is the height of the three parallelepipeds $I.K.E.$ and the root of the square of the bases of the other three parallelepipeds $F.H.L.$ and also the root or side of the parallelepipedon, or little cube G . Multiply therefore 1200 by 5 , for the whole contents of the parallelepipeds $I.K.E.$ viz. 6000 ; and squaring the said 5 for the bases of the three parallelepipeds $F.H.L.$ multiply their three heights 60 , by the said square of their bases, the product is 1500 , their whole contents; under which setting down also the cube of 5 , viz. 125 , for the content of the parallelepipedon G . the sum of these three numbers I find to be just 7625 , exactly equal to the resolvend; which shows the number given to be a perfect cube, whose root is exactly 25 .

To make all more plain, for the work at length, with the vacant places filled with cyphers.

~~1200 Bases of Parallelepipeds I.K.E.~~
~~60 Height of Parallelepipeds F.H.L.~~
~~1260 Divisor.~~
~~6000 Content of Parallelepipeds I.K.E.~~
~~1500 Content of Parallelepipeds F.H.L.~~
~~125 Content of Parallelepipedon G.~~
~~7625 Total, or Abbatissium.~~

7625 Remainder & Resolvend.

25 Root.

1200 Bases of Parallelepipeds I.K.E.

60 Height of Parallelepipeds F.H.L.

1260 Divisor.

6000 Content of Parallelepipeds I.K.E.

1500 Content of Parallelepipeds F.H.L.

125 Content of Parallelepipedon G.

7625 Total, or Abbatissium.

... 0

P R O O F.

The proof of this extraction, is by multiplying the root found, first by itself, and that product again by the root; adding the remainder, if there be any, to the last product: thus,

$$\begin{array}{r}
 \text{multiply'd by } 25 \text{ the Root.} \\
 25 \\
 \hline
 125 \\
 50 \\
 \hline
 \text{gives } 625 \\
 \text{again by } 25 \text{ the Root.} \\
 \hline
 3125 \\
 1250 \\
 \hline
 \text{gives } 15625
 \end{array}$$

To find the fractional Part of the Root.

Add to the number given, so many tenths of cyphers, as you would have places of decimal parts in the root, and proceed by the foregoing rules. As suppose 865635 were given for an example.

EXAMPLE

E X A M P L E

267	637	000	000	000	(95,304 Rem.
729					
136	637				1st Division
24	3				
	27				
24	57				Divisor.
121	5				
6	75				
	125				
128	375				Allegation.
8	260	000			2d Division
2	707	5			
	2	85			
2	710	35			Divisor.
8	122	5			
	25	65			
		27			
8	148	177			Allegation.
	117	823	000		3d Division
	270	462	7		
		28	59		
	272	491	29		Divisor.
	171	823	000	000	4th Division
	27	246	270	0	
			285	90	
	27	246	555	90	Divisor.
108	985	080	0		
	4	574	40		
			64		
108	989	624	464		Allegation.
2	833	345	536		Remainder.

In

[296]

In this example, there being three turns of cyphers, the root shall have three decimal places.

Note, The divisor going as times in the third residend, the same figures are immediately brought down again, and with a new turn of cyphers form the 4th residend.

To extract the Cube Root of a Vulgar Fraction.

The cube root of a vulgar fraction is found after the same manner as the square root, viz. by finding the root of the numerator given for a new numerator, and the root of the denominator given for a new denominator.

Also, if the vulgar fraction be irreducible, it must be reduced to a decimal, as directed in the square root, and then extracted.

F I N I S.



